THE SENSES

AND

THE INTELLECT.

PREFACE.

THE object of this treatise is to give a full and systematic account of two principal divisions of the science of mind,—the Senses and the Intellect. The remaining two divisions, comprising the Emotions and the Will, will be the subject of a future treatise.

While endeavouring to present in a methodical form all the important facts and doctrines bearing upon mind, considered as a branch of science, I have seen reason to adopt some new views, and to depart, in a few instances, from the most usual arrangement of the topics.

Conceiving that the time has now come when many of the striking discoveries of Physiologists relative to the nervous system should find a recognized place in the Science of Mind, I have devoted a separate chapter to the Physiology of the Brain and Nerves.

In treating of the Senses, besides recognizing the so-called muscular sense as distinct from the five senses, I have thought proper to assign to Movement and the feelings of Movement a position preceding the Sensations of the senses; and have endeavoured to prove that the exercise of active energy, originating in purely internal impulses, independent of the stimulus produced by outward impressions, is a primary fact of our constitution.

Among the Senses, have been here enrolled and described with some degree of minuteness the feelings connected with the various processes of organic life,—Digestion, Respiration, &c.—which make up so large a part of individual happiness and misery.

A systematic plan has been introduced into the description of the conscious states in general, so as to enable them to be compared and classified with more precision than heretofore. However imperfect may be the first attempt to construct a Natural History of the Feelings, upon the basis of a uniform descriptive method, the subject of mind cannot attain a high scientific character until some progress has been made towards the accomplishment of this object.

In the department of the Senses, the Instincts, or primitive endowments of our mental constitution, are fully considered; and in endeavouring to arrive at the original foundation, or first rudiments, of Volition, a theory of this portion of the mind has been suggested.

In treating of the Intellect, the subdivision into faculties is abandoned. The exposition proceeds entirely on the Laws of Association, which are exemplified with minute detail, and followed out into a variety of applications.

LONDON, *June*, 1855.

PREFACE TO THE SECOND EDITION.

THIS edition has been thoroughly revised, and in many places re-written. Although I have not seen reason to change any of my leading views on the subject of mind, I hope I may have succeeded in improving the statement and exposition of them.

It is in the first part of the work where most alteration has been made. The explanations of the Nervous system and the Senses have been amended according to the best recent authorities on Physiology. The Definition of Mind has been somewhat differently expressed. The systematic plan of describing the Feelings has been modified, and all the detailed descriptions re-cast. An attempt has been made to generalize the Physical accompaniments of Pleasure and Pain. The Instinctive foundations of Volition are stated more explicitly.

In the second part, the Introduction to the Intellect has been revised, with a view to rendering as precise as possible the natural subdivisions of this portion of the mind. The doctrine referring to the physical seat of revived impressions has been discussed anew, and applied to clear up the difficulties attending the explanation of Sympathy. The associating principle of Contrast has, on farther consideration, been treated as the reproductive aspect of Discrimination, or Relativity.

The origin of our notions of Space and Time has been more minutely traced; and some additions have been made to the handling of the great Metaphysical problem, relating to the External World.

ABERDEEN, *February*, 1864.

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INTRODUCTION.

CHAPTER I.

DEFINITION AND DIVISIONS OF MIND.

1. THE operations and appearances that constitute Mind are indicated by such terms as Feeling, Thought, Memory, Reason, Conscience, Imagination, Will, Passions, Affections, Taste. But the Definition of Mind aspires to comprehend in few words, by some apt generalisation, the whole kindred of mental facts, and to exclude everything of a foreign character.

Mind is commonly opposed to Matter, but more correctly to the External World. These two opposites define each other. To know one is to know both. The External, or Object, World is distinguished by the property called Extension, which pertains both to resisting Matter, and to unresisting, or empty, Space. The Internal, or the Subject, World is our experience of everything not extended; it is neither Matter nor Space. A tree, which possesses extension, is a part of the object world; a pleasure, a volition, a thought, are facts of the subject world, or of mind.

Thus Mind is defined, in the first instance, by the method of contrast, or as a remainder arising from subtracting the External World from the totality of existence. It happens that the External World is easily defined or circumscribed; the one well-understood property, Extension, serves for this purpose. Hence the alternative, or the correlative, Mind, can be circumscribed with equal exactness. But it is desirable to possess, in addition to this negative definition, however precise it may be, a positive definition, or a specification of the quality or qualities that appertain to the phenomena designated mind. Now, we have not here the good fortune to be able to refer to a single precise quality, like Extension for the object world; we must refer to several qualities that conspire to make up our mental framework. Hence our positive definition, instead of being a unity, is a plurality, and is not only a Definition, but also a Division of the Mind.

2. The phenomena of the Inextended Mind are usually comprehended under three heads:—

I. FEELING, which includes, but is not exhausted by, our pleasures and pains. Emotion, passion, affection, sentiment—are names of Feeling.

II. VOLITION, or the Will, embracing the whole of our activity as directed by our feelings.

III. THOUGHT, Intellect, or Cognition.

Our SENSATIONS, as will be afterwards seen, come partly under Feeling, and partly under Thought.

The three classes of phenomena have each certain distinctive characteristics, and the sum of all these is a definition of mind by a positive enumeration of its most comprehensive qualities. There is no one fact or property that embraces all the three. We may have a single *name* for the whole, as Mind, the Subject, Consciousness, the Inextended; but it does not follow that one general property shall exhaust the whole. Volition is a distinct fact from Feeling, although presupposing it; and Thought is not necessarily implied in either of the two other properties.

3. A few remarks may here be offered, by way of elucidating this threefold definition and division.

First. For a notion of what Feeling is, we must refer each person to his own experience. The warmth felt in sunshine, the sweetness of honey, the fragrance of flowers, the beauty of a landscape, are so many known states of feeling.

Our pleasures and pains are all included under this head, as well as certain states that are neutral as regards pleasure and pain. The entire compass of our Feelings could be known only by an exhaustive enumeration; from which also we might expect to obtain a general definition of Feeling. It is not requisite at this stage that we should either classify the feelings, or arrive at their common or defining properties. It so happens that we can readily circumscribe this part of our mental being by that negative method already exemplified in the definition of mind as a whole: for the characters both of thought and of volition are remarkably intelligible and precise, and therefore give us a ready means of laying down the boundary of the remaining department.

We may, however, remark before passing to the consideration of the other divisions, that the presence of Feeling is the foremost and most unmistakeable mark of mind. The members of the human race agree in manifesting it. The different orders of the brute creation show symptoms of the same endowment. The vegetable and mineral worlds are devoid of it. True, it is each in ourselves that we have the direct evidence of the state; no one person's consciousness being open to another person. But finding all the outward appearances that accompany feeling in ourselves, to be present in other human beings, and, under some variety of degree, in the lower animals, we naturally conclude their internal state to be the same as our own. The gambols of a child, the shrinking from a blow, a cry on account of pain, and the corresponding expressions for mental states common to all languages, prove that men in every age and nation have been similarly affected. The terms for expressing pleasure and pain in their various forms and degrees, are names of feelings; joy, happiness, bliss, comfort, sorrow, misery, agony, —are a few examples out of this part of the vocabulary.

Secondly. All beings recognised as possessing mind can not only feel but also *act*. The putting forth of power to attain some end marks a mental nature. Eating, running, flying, sowing, building, speaking—are operations rising above the play of feeling. They all originate in some feelings to be satisfied, which gives them the character of proper mental actions. When an animal tears, masticates, and swallows its food, hunts its prey, or flees from danger, the stimulus or support of the activity is furnished by its sensations or feelings. To this feeling-prompted activity we give the name *Volition*.

This characteristic of being stimulated by the feelings of sentient beings makes a wide contrast between volition and the energies familiar to us in nature,—the powers of wind, water, gravity, steam, gunpowder, electricity, vegetation, &c. True, the impulse of personification, so spontaneous in man, has often compared these powers to a human will; but in reasoning about them scientifically no such comparison is admitted; while in the explanation of voluntary actions the reference to feeling and thought is indispensable.

Volition is farther contrasted with such animal functions as breathing, the circulation of the blood, and the movements of the intestines. These are actions, and serve a purpose, but they are not mental actions. We could imagine ourselves so constituted, that these processes would have had to be prompted and controlled by sensations, emotions, and desires; they would then have been mental actions. As it is, they form a class apart, denominated Reflex Actions. When narrowly examined, it is true, they appear to shade by insensible degrees into voluntary actions, but we are not on that account to confound the broad and fundamental distinction between the unconscious and the conscious, involved in the opposition of the reflex and the voluntary.

It is impossible, however, in a brief preliminary sketch to indicate and discriminate all the varieties of animal activity. There is a complication to be unravelled in this department of the mind such as to test severely the resources of mental science. It is sufficient to remark, as the most general law of volition, that pleasure prompts to action for its continuance, increase, or renewal; and that pain prompts to action for its cessation, abatement, or prevention.

Thirdly. The concluding attribute of the mental constitution is Thought, Intelligence, or Cognition. This includes such functions as Memory, Reason, Judgment, and Imagination. The first fact implied in it is *Discrimination* or sense of difference, as when we are conscious of one sensation as more intense than another, or when we are struck with two feelings as differing in kind,—for example, taste and smell, pain and pleasure, fear and anger. Another fact is *Similarity*, or sense of agreement, which is interwoven with the preceding in all the processes of thought. When we identify any sensation or present mental impression with one that occurred previously, there being an interval between, we exemplify the power of similarity. The sun seen to-day recalls our previous impressions of his appearance, through this power. A third fact or property of the Intellect is *Retentiveness*, commonly understood by the familiar names 'memory' and 'recollection.' This power is essential to the operation of the two former powers; we could not discriminate two successive impressions, if the first did not persist mentally to be contrasted with the second; and we could not identify a present feeling with one that had left no trace in our framework. Retentiveness, which sums up all that we understand by memory, acquisition, education, habit, learning by experience, is not wanting in the lower orders of sentient life. For an animal to have a home, a certain degree of memory is requisite.

We have seen that volition is separated from Feeling, by superadding the characteristic of *action*, or the putting forth of energy to serve an end. And now, after the foregoing enumeration of Intellectual attributes, we can draw the line between Thought and Feeling, which is to complete the definition of mind, so far as is needful at the outset.

In proportion as a mental experience contains the operations of discrimination, comparison, and retentiveness, it is an intellectual experience; and in proportion as it is wanting in these, and shews itself in pleasure or pain, it is of the nature of feeling. The very same state of mind may have both an intellectual side and an emotional side; indeed, this is a very usual occurrence. And, like many things that are radically contrasted, as day and night, these two distinct facts of our nature pass into one another by a gradual transition, so that an absolute line of separation is not always possible; a circumstance that does not invalidate the genuineness of their mutual contrast.

The exercise of Thought is greatly mixed up with Volition also, but there is rarely any difficulty in distinguishing the two functions. Indeed it is hardly possible for us to exist in one exclusive state. Still, in our explanations of things, we often require to separate in discussion what is not separated in fact.

4. If we advert to the various classifications of the mental phenomena that have hitherto passed current, we shall find that the three attributes above specified have been more or less distinctly recognised.

In the division of mind into *Understanding* and *Will*, the element of Feeling would appear to be left out entirely. We shall find in fact, however, that the feelings are implied in, or placed under, both heads. The same remark applies to Reid's classification, also twofold and substantially identical with the foregoing, namely into *Intellectual Powers* and *Active Powers*. The submerged department of Feeling will be found partly mixed up with the Intellectual Powers, wherein are included the Senses and the Emotions of Taste, and partly treated of among the Active Powers, which comprise the exposition of the benevolent and malevolent Affections.

Dr Thomas Brown, displeased with the mode of applying the term 'Active' in the above division, went into the other extreme, and brought forward a classification where Feeling seems entirely to overlie the region of Volition. He divides mental states into *external affections* and *internal affections*. By external affections he means the feelings we have by the Senses, in other words Sensation. The internal affections he subdivides into *intellectual states of mind* and *emotions*. His division therefore is tantamount to Sensation, Emotion, and Intellect. All the phenomena commonly recognised as of an active or volitional character he classes as a part of Emotion.

Sir William Hamilton, in remarking on the arrangement followed in the writings of Professor Dugald Stewart, states his own view as follows:—'If we take the Mental to the exclusion of Material phœnomena, that is, the phœnomena manifested through the medium of Self-consciousness or Reflection, they naturally divide themselves into three categories or primary genera;—the phœnomena of Knowledge or Cognition,—the phœnomena of Feeling or of Pleasure and Pain,—and the phœnomena of Conation or of Will and Desire.'* Intelligence, Feeling, and Will are thus distinctively set forth.

The three-fold division was recognised in Germany long before its adoption in England. Kant, in his Critique of Judgment, says:—'All the powers or capabilities of the soul can be reduced to three, which cannot themselves be deduced from a common source: the Power of Cognition, the Feeling of Pain and Pleasure, and the Power of Desire.' Although Kant did not always give equal prominence to this classification, it was generally adopted by later writers. Herbart, the most distinguished name in this part of mental philosophy in Germany posterior to Kant, places the division in the foreground of his system, and considers that the three members of it present the highest, and at the same time the clearest, conceptions that we can form of mental phenomena, although at a further stage he subordinates Feeling and Will (in their derivation) to Cognition, maintaining both to be relations existing among Cognitions. Among subsequent writers the triple classification is constantly assumed, different views being held as to the mutual dependence of the three functions; but the majority regard them as not reducible into any more comprehensive property of mind.

I may farther notice the mode of laying out the subject that has occurred to an able physiologist. I quote a passage

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* Collected Works of Dugald Stewart, Vol. II.: Advertisement by the Editor.

intended as introductory to the Antomy of the Nervous System.

'Of the functions performed through the agency of the nervous system, some are entirely corporeal, whilst others involve phenomena of a mental or psychical nature. In the latter and higher class of such functions are first to be reckoned those purely *intellectual operations*, carried on through the instrumentality of the brain, which do not immediately arise from an external stimulus, and do not manifest themselves in outward acts. To the same class also belong *sensation* and *volition*. In the exercise of sensation the mind becomes conscious, through the medium of the brain, of impressions conducted or propagated to that organ along the nerves from distant parts; and in voluntary motion a stimulus to action arises in the brain, and is carried outwards by the nerves from the central organ to the voluntary muscles. Lastly, *emotion*, which gives rise to gestures and movements, varying with the different mental affections which they express, is an involuntary state of the mind, connected with some part of the brain, and influencing the muscles through the medium of the nerves.'*

In this passage a quadruple partition is indicated,—Sensation, Intellect, Emotion, and Volition. Sensation is raised to the rank of a primary division. Except, however, as regards one important point to be afterwards adverted to, there is nothing in Sensation that does not come under either Feeling, as above defined, or Intellect.

5. In the plan of the present volume, part first, entitled Movement, Sense, and Instinct, will include the discussion of both Feeling and Volition in their lower forms, that is, apart from Intellect, or so as to involve Intellect in the least possible degree; the Sensations of the different Senses will form a leading portion of the contents. This book will comprise all that is primitive or instinctive in the susceptibilities and impulses of the mental organization. The second part will propose to itself the full exposition of the Intellectual phenomena.

Thus, while regarding Feeling, Volition, and Intellect, as

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* Dr Sharpey, in QUAIN's *Anatomy*, 6th edition, p. clxviii.

the ultimate properties and the fundamental classification of mind, we do not propose that the exposition should proceed strictly in the order in which those are stated.

Although Feeling and Volition, in their elementary aspect, can be explained before entering on the consideration of the Intellect, while one large important department of Feeling, namely, Sensation, is always considered as introductory to the Intellectual powers, yet the full exposition of the emotions and active impulses of our nature properly comes last in the systematic arrangement of the subject of mind.

6. It is perhaps proper at the very outset to give some intimation of a great mental law involved in the fundamental property of Discrimination above noticed, namely, the law of Relativity. By this is meant that, as change of impression is an indispensable condition of our being conscious, or of being mentally alive either to feeling or to thought, every mental experience is necessarily twofold. We can neither feel nor know heat, except in the transition from cold. In every feeling there are two contrasting states; in every act of knowing, two things are known together.

With reference to many of our common feelings, mankind have always to some extent recognised the working of this principle. It is known that the first shock of the transition from one state to another—from sickness to health, poverty to abundance, ignorance to knowledge—is the most intense, and that as the memory of the previous condition fades away, so does the liveliness of the emotion caused by the change. Leisure, retirement, rest, are enjoyed only by contrast to previous toils. The incessant demand for novelty and change, for constant advances in wealth, in knowledge, in the arrangements of society, shows the principle of relativity as applied to pleasure.

Our language contains many names avowedly relative, as parent, child; ruler, subject; up, down; north, south; light, dark; virtue, vice. It is known that either name in those couples implies the other; there can be no ruler without a subject. But the principle of Relativity applies to everything that we are capable of knowing. Whatever we can conceive implies some other thing or things also conceivable, the contrast, co-relative, or negative of that. Red means the exclusion of all the other colours. If we had never been affected by any colour except red, colour would never have been recognised by us. When we speak of a fixed star, we mean to exclude certain other things—the sun, planets, comets, &c. When we make an affirmation, 'the stars shine by their own light,' we also by implication make a denial, 'the stars do not borrow their light.'

The applications of this principle are numerous and important. It bears directly on the arts of human happiness; it is essentially involved in Fine Art; it must be considered in the communication of knowledge; in Metaphysics it conflicts with the doctrine of the Absolute. (For farther remarks on the Definition and Divisions of Mind, see Appendix A.)

CHAPTER II.

OF THE NERVOUS SYSTEM.

1. THE connexion of the mental processes with certain of the bodily organs is now understood to be of the most intimate kind. A knowledge of the structure of those organs may therefore be expected to aid us in the study of mind. The contribution at present obtained from this source is something considerable; which makes it not improper to introduce a small portion of the Anatomy and Physiology of the human body into the present work. The parts of the human frame that chiefly concern the student of mental science are the Nerves and Nerve Centres (principally collected in the Brain), the Organs of Sense, and the Muscular System. The organs of sense and of movement will fall to be described in Book First; a brief description of the Nerves and Nerve Centres will occupy this preliminary chapter, in which we shall confine ourselves as far as possible to the facts bearing directly upon Mind, introducing only such further explanations as may be needed to make those facts clear and evident.

2. That the Brain is the principal organ of Mind is proved by such observations as the following:—

(1.) From the local feelings that we experience during mental excitement. In most cases of bodily irritation we can assign the place or seat of the disturbance. We localise indigestion in the stomach, irritation of the lungs in the chest, toothache in the gums or jaws, and when the mental workings give rise to pain we point to the head. In ordinary circumstances the action of the brain is unconscious, but in a time of great mental agitation, or after any unusual exertion of thought, the aching or oppression in the head tells where the seat of action is, precisely as aching limbs prove what muscles have been exercised during a long day's march. The observation can occasionally be carried much farther; for it is found that a series of intense mental emotions, or an excessive action of the powers of thinking, will end in a diseased alteration of the substance of the brain.

(2.) Injury or disease of the brain impairs in some way or other the powers of the mind. A blow on the head will destroy consciousness for the time; a severe hurt will cause a loss of memory. The various disorders of the brain, as for example, softening, &c., are known to affect the mental energies. Insanity is often accompanied by palpable disease of the cerebral substance, as shown by outward symptoms durng life and by dissection after death.

(3.) The products of nervous waste are increased when the mind is more than ordinarily exerted. The alkaline phosphates (the triple phosphate of ammonia and magnesia), removed by the kidneys are derived principally from the waste of nervous substance; and these are sensibly increased after great mental exertion or excitement. Phosphorus abounds more in the brain than in any other tissue.

(4.) There is an indisputable connexion between size of brain and the mental energy displayed by the individual man or animal. It cannot be maintained that size is the only circumstance that determines the amount of mental force; *quality* is as important as quantity, whether in nerve, muscle, or any other portion of the animal structure. But just as largeness of muscle gives greater strength of body as a general rule, so largeness of brain gives greater vigour of mental impulse. The facts proving the large size and great weight of the heads of remarkable men have often been quoted. 'All other circumstances being alike,' says Dr. Sharpey, 'the size of the brain appears to bear a general relation to the mental power of the individual,—although instances occur in which this rule is not applicable. The brain of Cuvier weighed upwards of 64 oz., and that of the late Dr. Abercrombie about 63 oz. avoirdupois. On the other hand, the brain in idiots is remarkably small. In three idiots, whose ages were sixteen, forty, and fifty years, Tiedemann found the weight of their respective brains to be 19¾ oz., 25¾ oz., and 22½ oz.; and Dr. Sims records the case of a female idiot twelve years old, whose brain weighed 27 oz. The weight of the human brain is taken at about 3 lbs. (48 oz.)'—QUAIN'S *Anatomy*, Vol. II., p. 432.*

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* In a paper by Mr. John Marshall, of University College Hospital, read before the Royal Society, (June, 1863), the author gives a minute account of three brains, one the brain of a Bushwoman, the others the brains of two idiots of European descent. The Bushwoman's brain was computed to have weighed in the fresh state 31½ oz. One of the idiots was a woman aged forty-two years; she was able to walk though badly, to nurse a doll, and to say a few words; the weight of her brain was 10 oz. 5 grs. The other was a boy of twelve; he could neither walk nor handle anything, nor articulate a single word; the weight of his brain was 8½ oz. These are the two smallest idiot brains whose weight has been recorded.

Mr. Marshall enters into a very minute description of the structure of all the three brains, and his remarks are valuable as showing what other peculiarities, besides weight, attach to the brains of human beings of low mental power. The cerebrum in idiots is not merely a small organ, having all the proper parts on a smaller scale, but these parts are fewer in number, less complex, and different in relative proportion and position. And in particular, the convolutions of the brain are much less developed, much simpler, than in an average brain. On comparing the two idiots in question, the convolutions of the woman were more developed than those of the boy.

The circumstance of inequality in the richness of the convolutions, has been alluded to by physiologists as explaining the cases of great mental power allied with brains not above the average weight. Such differences have actually been observed in the examination of brains. The brain of Cuvier was said to be distinguished in this respect, as well as in weight. Hence it might be supposed that we have here a sufficient explanation of the cases where weight and mental power do not go together, and may thereby dispense with the assumption made in the text as to difference of quality in the nervous substance. Unfortunately, however, the connection of force of mind with richness of convolutions is also liable to exceptions. It is not uniformly supported by Comparative Anatomy,—the sheep's brain is more highly convoluted than the dog's; and there are well authenticated cases of men of superior powers, whose brains both in weight and in convolutions were below the average. Still, there can be no doubt that generally, though not universally, an increase in one or both of these peculiarities is the concomitant of a higher mental endowment. The statistics of the Races of men, and Comparative Anatomy, are decisive to this extent.

(5.) The specific experiments on the nerve cords and nerve centres, to be afterwards quoted, have proved the immediate dependence of sensation, intelligence, and volition on those parts.

No fact in our constitution can be considered more certain than this, that the brain is the chief organ of mind, and has mind for its principal function. As we descend in the animal scale, through Quadrupeds, Birds, Reptiles, Fishes, &c., the nervous system dwindles according to the decreasing measure of mental endowment.

3. 'The NERVOUS SYSTEM consists of a *central part*, or rather a series of connected *central organs* named the *cerebro-spinal axis*, or *cerebro-spinal centre*;* and of the *nerves*, which have the form of cords connected by one extremity with the cerebro-spinal centre, and extending from thence through the body to the muscles, sensible parts, and other organs placed under their control. The nerves form the medium of communication between these distant parts and the centre; one class of nervous fibres, termed *afferent* (in-bringing) or *centripetal*, conducting impressions towards the centre,—another, the *efferent* (out-carrying) or *centrifugal*, carrying material stimuli from the centre to the moving organs. The nerves are, therefore, said to be internuncial in their office, whilst the central organ receives the impressions conducted to it by the one class of nerves, and imparts stimuli to the other, rendering certain of these impressions cognizable to the mind, and combining in due association, and towards a definite end, movements, whether voluntary or involuntary, of different and often of distant parts.'—QUAIN, Introduction, clxix.

The foregoing division of the nervous system into nerve-centres and nerve-cords determines the order and method of description both as regards their Anatomy, or structure, and their Physiology, or function.

* Being contained partly within the head, and partly within the spine, or back-bone.

OF THE NERVOUS SUBSTANCE.

4. For the full details of the structure of nerve, as regards both the ultimate elements of cell and fibre, and the masses made up of these elements, reference must be had to the best works of Anatomy. In the present state of our knowledge, the entire significance of these details cannot be assigned; Physiology on the one hand, and mental science on the other, must be in a more advanced condition in order to make out such significance. Nevertheless, there are certain leading features of the nerve structure that are even now of interest in the study of mind. I quote again from Dr. Sharpey's contributions to the 6th edition of QUAIN'S *Anatomy.*

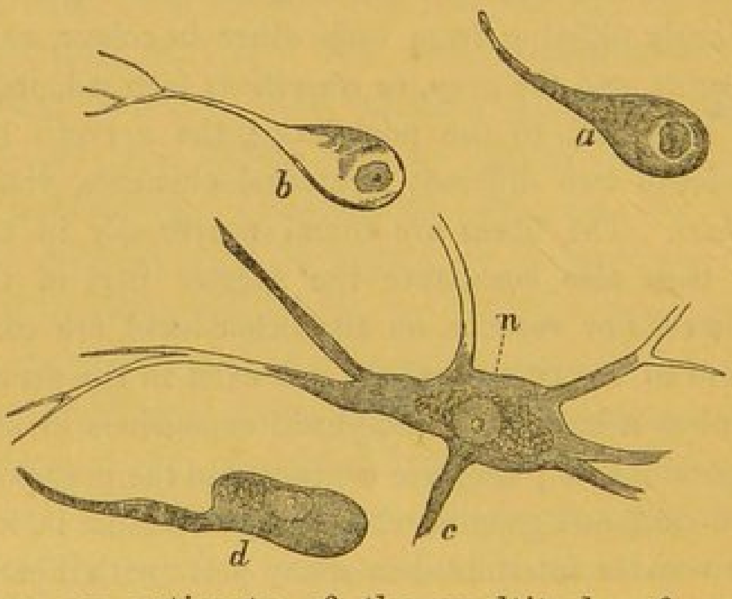
'The nervous system is made up of a substance proper and peculiar to it, with inclosing membranes, cellular tissue, and blood vessels. The *nervous substance* has long been distinguished into two kinds, obviously differing from each other in colour, and therefore named the *white*, and the *grey*, or *cineritious* (ash coloured).

'When subjected to the microscope, the nervous substance is seen to consist of two different structural elements, viz., *fibres*, and *cells* or *vesicles.* The fibres are found universally in the nervous cords, and they also constitute the greater part of the nervous centres; the cells or vesicles, on the other hand, are confined in a great measure to the latter, and do not exist in the nerves properly so called, unless it be at their peripheral expansions in some of the organs of special sense; they are contained in the grey portion of the brain, spinal cord, and ganglia, which grey substance is, in fact, made up of these vesicles intermixed in many parts with fibres, and with a variable quantity of granular or amorphous matter.'—Introduction, p. clxxii.

The author goes on to describe the nerve fibres as of two distinct kinds, and the nerve cells as consisting of several varieties, but to us it must suffice to know, that the nerve cords or connexions are bundles of separate fibres, and that the nerve centres are aggregates of cells or vesicles mixed with fibres.

The mode of connexion of nerve threads with the central vesicles is not uniform. In one class of cases the vesicles are pear-shaped, and send out tails that are the commencement of fibres, so that the cells are, as it were, swellings or expansions of the fibres, having granular or solid nuclei enclosed in them. According to this plan, in any nerve cord going from the extremities of the body to the brain, the separate fibres would end each in a swollen mass or vesicle, and the total of these vesicles would be the grey matter of the brain. To this grey matter, with its infinitude of cells, all the nerves tend, or from it they issue. These two elements of nerve cell and nerve fibre are the sole ingredients peculiar to the brain. The blood vessels are common to it with every other organ; whilst the membranes or sheaths that surround the cords and enclose the brain, serve partly for protection and insulation, and partly for containing and distributing the blood vessels.

FIG. 1.*



To form an estimate of the multitude of nerve fibres entering into the ramifying cords, it is necessary to be made aware of the size of the ultimate filaments. 'Their size differs considerably even in the same nerve, but much more in different parts of the nervous system; some being as small as the $\frac{1}{14000}$, and others upwards of $\frac{1}{1500}$ of an inch in diameter;

* 'Nucleated nerve-cells magnified 170 diameters. *a* and *b* from the cortical grey matter of the zerebellum; *c* and *d* from the spongy grey matter of the medulla oblongata. *n* the nucleus of a cell,—(*a*, *c*, and *d*, after Hannover).' From QUAIN'S *Anatomy*, p. clxxx.

and the same fibre may change its size in different parts of its course.' Thus it would appear that a nerve branch, like the main trunk supplying the arm, might contain hundreds of thousands of separate fibres. The optic nerve of one of the eyes might contain as many as a million of fibres.

The nerve vesicles also differ greatly from one another in size; some being scarcely larger than a human blood corpuscle,* others $\frac{1}{300}$ of an inch or upwards in diameter. We may, therefore, speak in somewhat similar terms respecting the countless millions of nerve cells, existing in the grey substance of a single convolution of the brain.

'As regards the vesicles existing in the grey matter of the convolutions of the brain, Dr. Lionel Beale gives the following conclusions as the result of his observations of the brain in man, the sheep, the cat, and the dog:—

'1. The numerous nerve cells of the grey matter are all connected with, or give origin to, at least two fibres.

'2. These fibres, wide near their origin, gradually diminish in thickness till they are not more than $\frac{1}{100,000}$ of an inch in diameter.

'3. It is probable that the cells of the grey matter of the convolutions are connected together; but in the adult the cells are not often connected with those cells situated nearest them.

'4. There is no reason for supposing that the nerve cells, here or elsewhere, influence any nerve fibres save those that are *structurally continuous* with them.' (Proceedings of the Royal Society, Vol. XII., p. 673.)

The minuteness of the fibres and the vesicles of the nerve substance is not without importance; for we are to consider that each fibre carries forward its own distinct impression without affecting, or being affected by, the impressions passing along the other fibres that run side by side with it in the same bundle. In the act of perceiving the objects about us, this distinctness enables us to hold in our minds all the parts of a

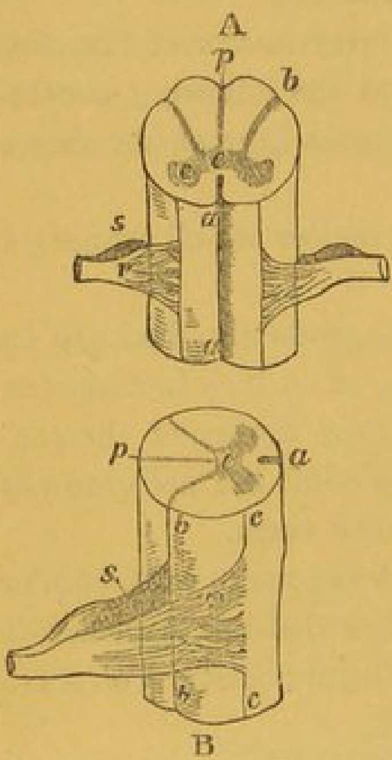
* The magnitude of the red corpuscles of the human blood 'differs somewhat even in the same drop of blood, and it has been variously assigned by authors; but the prevalent size may be stated at from $\frac{1}{3500}$ to $\frac{1}{3200}$ of an inch in diameter, and about one-fourth of that in thickness.

complicated scene, each in the proper place, without mingling or confusion; and, in the command of our muscular movements, it gives the means of singling out specific muscles to be acted on, while all the others are left quiescent.

OF THE NERVOUS CENTRES.

5. In the collective mass made up of the brain and spinal cord, and denominated the cerebro-spinal axis or centre, the following parts stand distinct from each other, although mutually connected by bundles of nerve fibres.

Fig. 2.*



I. The Spinal Cord, contained in the back bone, and sending out two pairs of nerves from between every two vertebræ, one pair to each side of the body. The Cord consists of a column of white fibrous matter with a grey portion enclosed. In a cross section, the grey matter is seen to form two crescents with the horns turned outwards, aud connected in the middle of their convexities by a cross band.

II. The Encephalon or Brain. This includes the entire contents of the cavity of the skull, or cranium. The spinal cord is continued up into it. The brain is itself an aggregate of distinguishable masses of mixed grey and white matter. Each of these masses is looked upon either as a distinct

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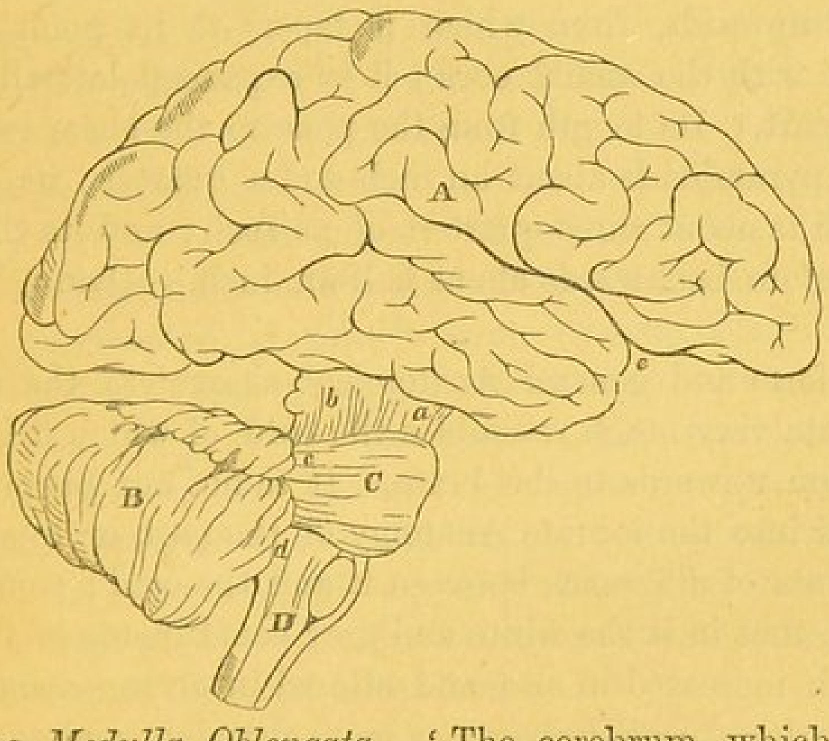
* 'Plans in outline, showing the front, A, and the sides, B, of the spinal cord with the fissures upon it; also sections of the grey and white matter, and the roots of the spinal nerves. *a*, *a*, Anterior fissure. *p*, *p*, Posterior fissure. *b*, Posterior, and *c*, Anterior horn of grey matter. *e*, Grey commissure. *r*, Anterior, and *s*, Posterior roots of a spinal nerve.'—Quain, Vol. II. p. 438.

centre, or as communicating between the centres. In proportion as the grey vesicular matter prevails, the mass has the character of a centre; according as the white fibrous substance prevails, the part serves as a medium of conduction or communication solely. Of these various masses, some have a preponderance of grey, others of white matter. None are purely of one kind.

The mere mechanical arrangement of the brain is exceedingly complex, and there are different modes of classifying and grouping the various portions. The division adopted by human Anatomists is into four parts (a different arrangement has been proposed, founded on Comparative Anatomy). Those four parts are the *Cerebrum*, the *Cerebellum*, the *Pons Varolii*,

Fig. 3.*



and the *Medulla Oblongata*. 'The cerebrum, which is the highest and by far the largest part of the human encephalon, occupies the upper and larger portion of the cranial cavity.' 'The cerebellum is placed beneath the hinder part of the

* 'A plan in outline, showing, in a lateral view, the parts of the encephalon separated somewhat from each other. A, Cerebrum. *e*, Fissure of Sylvius, which separates the anterior and middle lobes. B, Cerebellum. C, Pons Varolii. D, Medulla oblongata. *a*, Peduncles of cerebrum; *b*, Superior; *c*, Middle; and *d*, Inferior peduncles of cerebellum.'—Quain, p. 681.

cerebrum, by which it is completely overlapped.' The pons Varolii is in the base of the brain near the entrance of the spinal cord, and connects together the three other parts,—the cerebrum, the cerebellum, and medulla oblongata. The medulla oblongata connects the spinal cord with the brain.

6. In giving a more detailed description of those four parts, it will be convenient to take them in an inverse order, beginning from below, or where the brain joins the spinal cord.

(1.) The *Medulla Oblongata.*—This portion is continuous below with the spinal cord, of which it seems an expansion; lying wholly within the cranial cavity, its upper end passes into the pons Varolii. See Figs. 3 and 4, D.

'It is of a pyramidal form, having its broad extremity turned upwards, from which it tapers to its point of connexion with the spinal cord; it is expanded laterally at its upper part. Its length from the pons to the lower extremity of the pyramids is about an inch and a quarter; its greatest breadth is about three quarters of an inch; and its thickness from before backwards about half an inch.'—*Quain,* Vol. II. p. 444.

In form and general Anatomical characters, the medulla oblongata very much resembles the cord, of which it is a prolongation upwards to the brain. It is not our purpose here to enter into the minute Anatomy of the part, or to set forth he points of difference between it and the cord; suffice it to observe that in it the white and grey constituents of the cord are both increased in size and altered in arrangement. The grey matter especially becomes more abundant and additional deposits occur. The medulla oblongata has thus more of the character of an independent centre of nervous action than belongs to the cord. It gives origin to several nerves of a very special and important nature.

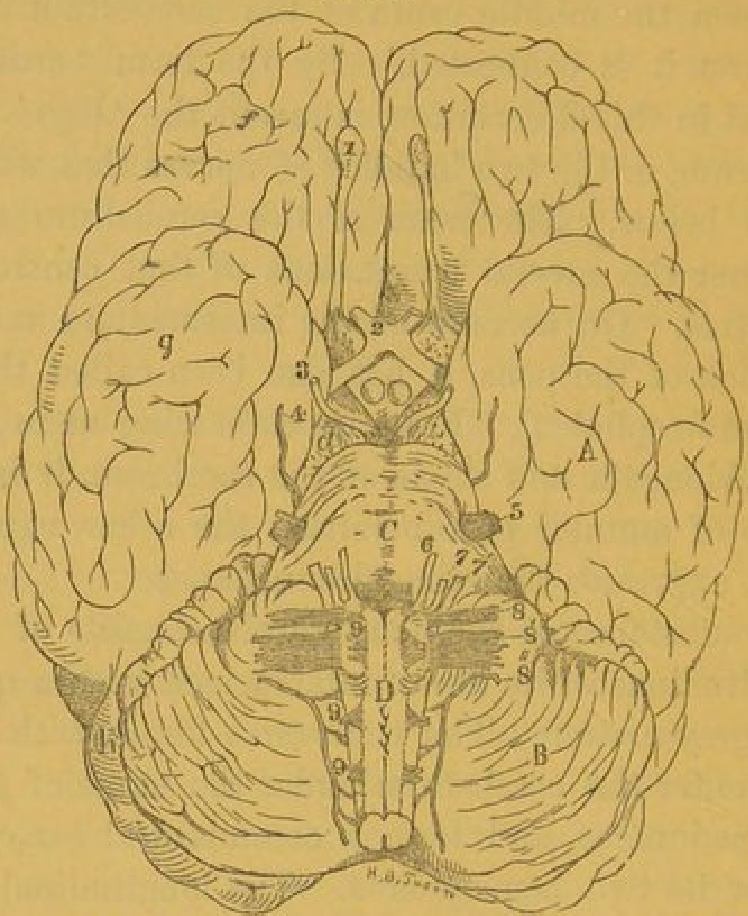
(2.) The *Pons Varolii,* or *annular protuberance* (tuber annulare). (See Figs. 3 and 4, C.) This 'is a comparatively small portion of the encephalon, which occupies a central position on its under surface, above and in front of the medulla oblongata, below and behind the crura cerebri *a*, and between the middle crura of the cerebellum *c*, with all which parts it is connected.' By the term 'crura cerebri,' introduced in this description, is meant the 'legs' or roots of the cerebrum, or the two bundles of nerves that unite it with the parts below. The crura of the cerebellum express in like manner the several connexions of that centre with the other centres. On account of the intermediate and connecting position of the pons, it has also been called the middle-brain (meso-cephalon). From its embracing as in a ring the medulla oblongata and stems of the cerebrum, it has derived the name of annular protuberance; the other name, 'pons,' or bridge, expresses the same circumstance.

'The substance of the pons Varolii consists of transverse and longitudinal white fibres, interspersed with a quantity of diffused grey matter. The transverse fibres, with a few exceptions, enter the cerebellum under the name of the middle crura or peduncles, and form a commissural (or connecting) system for its two hemispheres. The longitudinal fibres are those which ascend from the medulla oblongata into the crura cerebri, augmented, it would seem, by others which arise within the pons from the grey matter scattered through it.'—*Quain*, Vol. II., p. 451. The pons is thus mainly a grand junction between the medulla oblongata and spinal cord below, the cerebrum above, and the cerebellum behind. The existence of a considerable amount of the grey or vesicular matter proves that conduction or communication is not the sole function of this part of the brain.

(3.) 'The *cerebrum* or brain proper (Figs. 3 and 4, A), as already mentioned, is the highest, and by far the largest portion of the encephalon. It is of an ovoid (or egg) shape, but is irregularly flattened on its under side. It is placed in the cranium with its small end forwards, its greatest width being opposite to the parietal eminences.

'The cerebrum consists of two lateral halves, or *hemispheres*, as they are called, which, though connected by a median portion of nervous substance, are separated in a great

Fig. 4.*



part of their extent by a fissure, named the great longitudinal fissure, which is seen on the upper surface of the brain, and partly also on its base.

'The cerebral hemispheres are not plain or uniform upon the surface, but are moulded into numerous smooth and tortuous eminences, named *convolutions*, or gyri, which are marked off from each other by deep furrows, called sulci, or *anfractuosities*. These convolutions are coloured externally; for the surface of the cerebral hemispheres, unlike the parts hitherto described, is composed of grey matter.'—Quain, Vol. II., p. 451.

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* Shows the under surface or base of the encephalon freed from its membranes. A, Cerebrum, *f*, *g*, *h*, Its anterior, middle, and posterior lobes. B, Cerebellum. C, Pons Varolii. D, Medulla Oblongata. *d*, Peduncle of cerebrum. 1 to 9, indicate the several pairs of cerebral nerves, numbered according to the usual notation, viz. :—1, Olfactory nerve. 2, Optic. 3, Motor nerve of eye. 4, Pathetic. 5, Trifacial. 6, Abducent nerve of eye. 7, Auditory, and 7′, Facial. 8, Glosso-pharyngeal. 8′, Vagus. 8″, Spinal accessory nerve. 9, Lingual or hypoglossal nerve.

The complete description of the cerebrum includes an account of the external surface with its convolutions, and of the various masses that make up the interior and in part appear at the base of the brain. Although in the highest degree interesting as a study, no important application to our present subject arises out of such minute knowledge. There are, however, a few particulars that it is of use for us to add, selected out of the elaborate detail of cerebral Anatomy.

A distinction exists between the convoluted mass of the hemispheres and certain enclosed smaller masses of the cerebrum. Of these there are two that are usually named together, partly on account of their proximity, and partly because it has not been practicable to distinguish completely their functions. They are the *optici thalami* and *corpora striata*, being double and symmetrical on the two sides. They both lie imbedded in the heart of the hemispheres. The peduncles or stems of the cerebrum pass into them before spreading out into the mass of the hemispheres. The third important mass is termed the *corpora quadrigemina* (quadruple bodies),* from consisting of four rounded masses put together in a square. This portion is more detached than the two others, and finds a place between the cerebrum and cerebellum. In some of the inferior animals it is very large, and takes a prominent position in the general structure of the brain; wheaeas the two other masses above mentioned for the most part rise and fall according to the degree of development of the convoluted hemispheres. Hence the comparative Anatomist assigns to the quadruple bodies a character and function apart from the rest of the cerebrum. I quote a short description of each of the three centres.

The *corpora striata* 'are two large ovid masses of grey matter, the greater part of which is imbedded in the middle of the white substance of the hemisphere of the brain.' 'The surface of the corpus striatum is composed of grey matter. At some depth from the

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* See in Fig. 3, the two rounded eminences behind *b*, the superior peduncle of the cerebellum. These represent the corpora quadrigemina in section.

surface white fibres may be seen cutting into it, which are prolonged from the corresponding cerebral peduncle, and give it the streaked appearance from which it has received its name.'

'The *thalami optici* (posterior ganglia of the brain) are of an oval shape, and rest on the corresponding cerebral crura, which they in a manner embrace. On the outer side each thalamus is bounded by the corpus striatum, and is then continuous with the white substance of the hemisphere.' 'The inner sides of the two thalami are turned to each other.' 'The optic thalami are white on the surface, and consist of several layers of white fibres intermixed with grey matter.'

'In front of the cerebellum are certain eminences, which may be reached from the surface of the brain. These are the corpora quadrigemina, and above them is the pineal gland.'

('The pineal gland (conarium) so named from its shape (pinus, conus, the fruit of the fir), is a small reddish body, which rests upon the anterior pair of the corpora quadrigemina.' 'It is about three lines (a quarter of an inch) in length, and its broad part, or base, is turned forwards, and is connected with the rest of the cerebrum by white substance.')

'The *corpora* or *tubercula quadrigemina* are four rounded eminences, separated by a crucial depression, placed two on each side of the middle line, one before the other. They are connected with the back of the optici thalami, and with the cerebral peduncles at either side.'

'The upper or anterior tubercles, are somewhat larger and darker in colour than the posterior. In the adult, both pairs are solid, and are composed of white substance outside, containing grey matter within.

'They receive bands of white fibres from below.'—'A white cord also passes up on each side from the cerebellum to the corpora quadrigemina, and is continued onwards to the thalami: these two white cords are the superior peduncles of the cerebellum. At each side, the corpora quadrigemina send off two white tracts, which pass to the thalami and to the commencements of the optic nerves.'

'In the human brain these quadrigeminal bodies are small in comparison with their size in the series of animals. In ruminant, soliped, and rodent animals, the anterior tubercles are much larger than the posterior, as may be seen in the sheep, horse, and rabbit. In the brains of carnivora, the posterior tubercles are rather the larger.

'In the fœtus this part of the brain appears very early, and then forms a large proportion of the cerebral mass. The eminences are at first single on each side, and hollow. They are constant in the brains of all vertebrate animals, but in fishes, reptiles, and birds, they are only two in number, and hollow. In marsupialia and monotremata, they are also two in number, but solid.'

In this brief allusion to the different parts composing the cerebrum, we have had to exclude the mention of many smaller portions. We have also avoided all allusion to the *ventricles* of the brain. These are enclosed spaces extending in various directions, and serving as boundaries *to* the other parts.*

(4) 'The *cerebellum, little brain,* or *after brain* (Figs. 3 and 4, B), consists of a *body* and three pairs of *crura* or *peduncles,*

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* The following passage may assist in giving a connected view of the cerebrum, and also of the nature of the ventricular cavities or space.

'The hemispheres are connected together in the middle by the corpus callosum, and it is obvious that the structures filling up the interpeduncular space, serve also as connecting media. Between the corpus callosum above and the peduncles below, the two hemispheres are partially separated from each other, so as to leave an interval, *the general ventricular space,* across which some slighter connecting portions of nervous substance pass from one hemisphere to another.

'Again, as seen in a transverse vertical section of the cerebrum, the peduncles diverge as they ascend towards the hemispheres, aud pass on each side through two large masses of grey matter, sometimes called ganglia of the brain,—at first through the thalamus opticus, and afterwards through a much larger mass named corpus striatum. These two masses of grey matter project somewhat, as smooth convex eminences, on the upper and inner surface of the diverging fibres of the peduncles. Immediately above the thalami and corpora striata, the hemispheres are connected together across the median plane by the corpus callosum ; and it is between the under surface of the latter, and the upper surfaces of the eminences mentioned and the interpeduncular structures, that the general ventricular space is situated in the interior of the cerebrum. The upper part of this space is again divided by a median vertical partition, so as to form the two *lateral* ventricles : below this, it forms a single cavity named the *third* or middle ventricle, which communicates with both the lateral ventricles above, and, below, with the ventricle of the cerebellum or *fourth* ventricle. The median vertical partition, which separates the lateral ventricles from each other, consists at one part (septum lucidum) of two layers, between which is contained the *fifth* and remaining ventricle of the brain.'—QUAIN, Vol. II. p. 463.

by which it is connected with the rest of the encephalon. They are named superior, middle, and inferior peduncles.

'The superior peduncles (Fig. 3, *b*) connect the cerebellum with the cerebrum through the corpora quadrigemina, as already stated. The inferior peduncles *d*, pass downward to the back part of the medulla oblongata. The middle peduncles, *c*, pass from the middle of the cerebellum around the outer side of the crura of the cerebrum, and meet in front of the pons Varolii, constituting its transverse fibres. They connect the two halves of the cerebellum below. All these peduncles consist of white fibres only; and they pass into the interior of the cerebellum at its fore part.'

'The *body* of the cerebellum A, being covered with cortical substance, is of a grey colour externally, but is rather darker on the surface than the cerebrum. Its greatest diameter is transverse: it is about three and a half or four inches wide, about two or two and a half from before backwards, and about two inches deep in the thickest part, but is much thinner all round its outer border.

'It consists of two lateral *hemispheres*, joined together by a median portion called the *worm*, or vermiform process, which in birds, and in some animals still lower in the scale, is the only part existing.'

'The body of the cerebellum at the surface, and for some depth, consists of numerous nearly parallel laminæ or folia, which are composed of grey and white matter, and might be compared with the gyri or convolutions of the cerebrum, but are smaller and not convoluted. These are separated by sulci of different depths.'—QUAIN, Vol. II. p. 482-3.*

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* The above is a brief outline of the parts of the brain, as given in the best works on human Anatomy. I shall here append a view of its divisions founded on the comparative Anatomy of the vertebrate series of animals, and with reference to the analysis of the cranium into vertebral sections. It is supposed that the bony parts of the head and face of any animal in this series is made up of four vertebræ, expanded and transformed for the accommodation of the brain, senses, and the other organs that distinguish the head from the rest of the spine. On a similar supposition, the brain would be looked upon as an expansion of as much of the spinal cord as would extend over the length of four vertebræ. When we descend in the scale, as low as fishes, we find a most apparent division of the encephalon into four segments, corresponding with the four vertebræ, whose expansion makes the head.

Proceeding upon this hint, Professor Owen makes a classification of the

7. We must next attend to the internal structure of the brain, considered as made up of the two kinds of matter, the grey, vesicular, or central substance, and the white, fibrous, or communicating substance. The distribution and arrangement of those two kinds of matter throw light upon the mode of action, or the peculiar kind of activity that distinguishes the brain. The subject is still a very obscure one, but not so obscure as it has been, and we can even now learn from it a better mode of conceiving the workings of the nervous system than what has come down to us from the times when nothing whatever was known. I still quote from Dr Sharpey.

'*White Part of the Encephalon.*—The white matter of the

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parts of the brain, which he considers applicable alike to the highest and lowest members of the vertebrate class. Beginning from behind, where the encephalon joins the spinal cord, he enumerates as follows, specifying at the same time what he considers the functions of the several segments.

I. *Epencephalon* (Hind-brain). This includes the hinder parts of the mass, namely, the medulla oblongata, the pons Varolii, and the cerebellum. These parts together form an aggregate centre for sustaining the functions of Respiration and Digestion, and for performing combined and rhythmical movements. The two first functions, Respiration and Digestion, are commonly conceived as attaching to the medulla oblongata. The pons Varolii is far more of a connecting organ than a centre. To the cerebellum belongs, as is supposed, the function of harmonizing complex movements, of the instinctive kind, such as walking on all fours. Of the functions of the brain, we shall, however, speak particularly again.

II. *Mesencephalon* (Middle-brain). The parts here intended are those next in order to the previous. They are the enclosed space, called the third ventricle, the corpora quadrigemina, with its connected organ, the pineal gland, and another small round mass in the same region named the Pituitary body or gland. This is considered the Centre of Vision, and of the movements prompted and regulated by vision.

III. *Prosencephalon* (Fore-brain). The hemispheres, including the corpora striata and thalami optici. This is reckoned the seat of the higher functions of mind, namely, Consciousness, Volition, and Intelligence. It is the portion whose enlargement distinguishes the human subject. In the fish and reptile it is surpassed in size by the members of the middle brain, the corpora quadrigemina being the chief of these.

IV. *Rhinencephalon* (Nose-brain). The olfactory lobe and crura. In man this is a very insignificant mass, lying over the nose and between the eyes. In the lowest vertebrate animals, it stands forward as the terminating segment of the brain. It is the centre of Smell.

encephalon consists of tubular fibres. The general direction which they follow is best seen in a brain that has been hardened by immersion in spirits, although it is true that we do not then trace the single fibres, but only the fine bundles and fibrous lamellæ which they form by their aggregation.

'The fibres of the cerebrum, though exceedingly complicated in their arrangement, and forming many different collections, may be referred to three principal systems, according to the general course which they take, viz.—1. *Ascending or peduncular fibres,* which pass up from the medulla oblongata to the hemispheres, and constitute the two crura or peduncles of the cerebrum. They increase in number as they ascend through the pons, and still further in passing through the optic thalami and striated bodies, beyond which they spread in all directions into the hemispheres. These were named by Gall the *diverging* fibres. 2. *Transverse* or *commissural fibres,* which connect the two hemispheres together. 3. *Longitudinal* or *collateral fibres,* which, keeping on the same side of the middle line, connect more or less distant parts of the same hemisphere together.'—QUAIN, Vol. II. p. 500.

This general classification is followed out by the author into minute details, full of interest in themselves, but too technical and too little instructive as regards the workings of mind, to be farther dwelt upon here. We shall now give an extract on the distribution of the grey matter, and then pass to the general view of the mechanism and mode of working of the brain, suggested by these descriptions of its component structure.

'*Grey Matter of the Encephalon.*—Considering the imputed physiological importance of the grey nervous substance, it may be well to mention connectedly the different positions in which it is found in the several parts of the encephalon.

'By far the larger amount is situated upon the convoluted surface of the cerebrum and the laminated surface of the cerebellum, forming, in each case, the external cortical layer of cineritious matter.'

I regret to have to omit a portion of the connected account of the spread of the grey matter in the parts in the interior and base of the brain, as including a number of terms that the reader has not been prepared for in the present sketch of the nervous system. We must rest satisfied with perusing, in addition to the above, the account of the distribution of grey substance in the larger portions, and in the parts already in some degree known to us.

'In the crura cerebri, the grey matter is collected into a dark mass; below this it is continuous with that of the pons and medulla oblongata, and through them with the spinal cord.' Thus though the crura cerebri are, in the main, connexions of white matter between the hemispheres and the parts below, yet, like the medulla oblongota and spinal cord, they contain in the interior a portion of the grey matter, and are to that extent centres of nerve force, as well as being conductors.

'In the centre of each of the corpora quadrigemina, grey matter is also found, and it occurs in the pineal gland (and in the corpora geniculata). These last bodies appear to be appendages of the large masses of grey matter, situated in the interior of the cerebrum, named the optic thalami; which again, are succeeded by the still larger collections of this substance, and indeed the largest situated within the brain,—viz., the corpora striata.'—Vol. II., p. 512.

8. *Plan of Structure indicated by the above arrangement of white and grey substance.*—The object of the present chapter being to ascertain, as far as possible, the mode of working of the brain and the connexion of its mechanism with the mental functions, we may here take a summary view of the plan of structure indicated by the foregoing description. We shall thus prepare the way for discussing, at a later stage, the precise kind of action that seems to be maintained throughout the different parts of the nervous system.

It would appear, then, that the cerebro-spinal centre, or the brain and spinal cord taken together, is an aggregate of distinct nervous masses or parts, each made up of a mixture of white and grey matter. The grey matter is the vesicular substance, consisting of cells or vesicles; the white matter is the fibrous substance, being made up of fibres bundled together. The grey matter is a terminus; to it the fibrous collections tend, or from it commence. The fibrous matter contained within any of the cerebral masses is placed there as a means of communicating with some portion or other of the layers, or other collections, of grey substance.

Beginning with the spinal cord,—which we have seen to be a rod or column of white matter or fibres, enclosing a slender core of grey substance;—if we trace the fibres of the cord upwards, we find them continuing into the medulla oblongata, the first and lowest portion of the brain. Of the whole mass of fibres entering the medulla oblongata, the larger portion pass up into the pons Varolii and the cerebellum; while a part terminates in the grey substance of the medulla itself; and from that grey substance other fibres take their rise and proceed onwards, in the company of the through-going fibres of the cord. Thus the emerging white matter of the medulla oblongata is partly the fibres that entered it, as a continuation of the cord, and partly the fibres originating in the grey central matter of the medulla, replacing, as it would seem, those that terminated there. From the pons Varolii, where we come next, the white fibres advance in various directions; intersecting with transverse fibres connecting the two halves of the cerebellum, and passing upwards towards the cerebrum proper. The fibres thus going upwards constitute the crura, peduncles, or stems of the cerebrum, and seem destined to terminate in the grey matter of the convuluted surface of the hemispheres. But in passing through the ganglia of the brain—the thalami optici and corpora striata—the arrangement described above is repeated; that is to say, while part of the fibres proceed through the ganglionic masses, the rest stop short in the grey substance of those masses, which grey substance gives origin to other fibres to pass out with those that had an uninterrupted course through the bodies alluded to. Both sets together—those passing through, and those originating in, the grey substance of the corpora striata, or thalami optici—constitute a portion of the white or fibrous substance of the hemispheres, spreading out and terminating in the grey matter, or cortical layer, of the convolutions. They are the first of three classes of fibres, described above, as constituting the white matter of the cerebrum; that is to say, the ascending or diverging class.

Whatever number of central masses we may calculate as interposed between the spinal cord beneath and the convoluted surface of the cerebrum, the manner of communication between them is found to be as now stated. The fibres passing between one intermediate mass and another are partly transmitted and partly arrested. Wherever grey matter exists, there is the commencement or termination of white matter. The fibres that enter the cerebellum from the medulla oblongata, terminate in whole, or in part, in its outer layer of grey substance, and in that substance a new set of fibres originate to pass to other parts of the brain, as the corpora quadrigemina, the hemispheres, &c., and from one half of the cerebellum to the other. The fibres spreading out, as already mentioned, in the hemispheres towards the convoluted grey surface, will have had very various origins. Some may perhaps have come all the way from the extremities of the body, passing by the spinal cord, medulla oblongata, cerebellum, pons Varolii, thalami optici, &c.; others have originated in the grey matter of the cord, passing without a break through all the intervening centres; a third class may have had their rise in the grey matter of the pons; a fifth in the cerebellum; a sixth in the corpora quadrigemina; others in the thalami optici or corpora striata; besides other more minute sources.

The arrangement may thus be seen to resemble the course of a railway train. The various central masses are like so many stations where the train drops a certain number of passengers and takes up others in their stead, whilst some are carried through to the final terminus. A system of telegraph wires might be formed to represent exactly what takes place in the brain. If from a general terminus in London a mass of wires were carried out to proceed towards Liverpool, and if one wire of the mass were to end at each station, while from the same station new wires arose, one for every station further on, a complete and perfectly independent connexion could be kept up between any two stations along the line. Calling the stations A, *b*, *c*, *d*, E; there would be from A the London terminus, the wires A*b*, A*c*, A*d*, AE; from *b*, would arise, *bc*, *bd*, *b*E; from *c*, *cd*, *c*E; and from *d*, *dc*, *d*E. The mass of wires found on the road at a point between *c* and *d*, would be AE, or the one through-going wire, *b*E and *bd*, *c*E and *cd*; five wires in all, which would be the number sustained throughout. This system of telegraph communication would be, so far as appears, the type of nervous communication among the various masses strung together in the cerebro-spinal axis or centre.

But although the general plan is admitted to be such as here described, there are doubts and difference of opinion as to the existence of any fibres performing the entire course from the surface of the body to the convolutions of the brain. These doubts arise partly from the qualitative difference of the white fibres of the cerebral hemisphere, which will be afterwards noticed. Accordingly, some physiologists maintain that the nerves from the extremities of the body do not, at the very farthest, proceed beyond the grey central masses of the hemispheres. Other physiologists, however, still incline to admit the possibility of such through-going fibres.

The application of this view of the plan of structure of the brain will appear in the sequel, after we have ascertained the distinctive functions or uses of the two kinds of nervous matter.

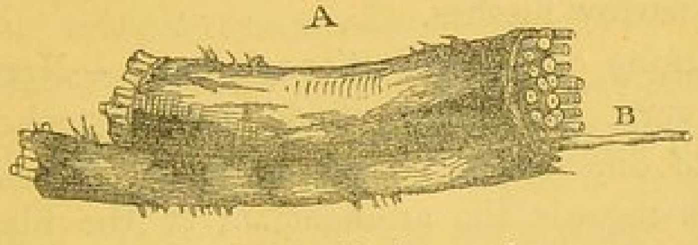
OF THE CEREBRO-SPINAL NERVES.

9. By the cerebro-spinal nerves are meant the connexions of the cerebro-spinal centre with the different parts of the body. These connexions consist of ramifications of nerve

cords, threads, or bundles, arising in the central masses, and distributed like the blood-vessels, by subdividing and spreading themselves over the various organs and tissues, thereby establishing a connection between the brain and the remotest extremities.

'These nerves are formed of the nerve fibres already described, collected together and bound up in membranous sheaths. A larger or smaller number of fibres inclosed in a tubular sheath form a small round cord, usually named a *funiculus*; if a nerve be very small, it may consist of but one such cord, but in larger nerves several funiculi are united together into one or more larger bundles, which, being wrapped up in a common membranous covering, constitute the nerve (Fig. 5.) Accordingly, in dissecting a nerve, we first come to an outward covering, formed of cellular tissue, but often so strong and dense, that it might well be called fibrous. From this common sheath we trace laminæ passing inwards, between the larger and smaller bundles of funiculi,

FIG. 5.*



and finally between the funiculi themselves, connecting them together as well as conducting and supporting the fine blood vessels which are distributed to the nerve.'

'The funiculi of a nerve are not all of one size, but all are sufficiently large to be readily seen with the naked eye, and easily dissected out from each other. In a nerve so dissected into its component fasciculi, it is seen that these do not run along the nerve as parallel insulated cords, but join together obliquely at short distances as they proceed in their course, the cords resulting from such union dividing in their further

* 'Represents a nerve consisting of many smaller cords or funiculi, wrapped up in a common cellular sheath. A, the nerve. B, a single funiculus drawn out from the rest (after Sir C. Bell).'—QUAIN, p. clxxxiv.

progress to form junctions again with collateral cords; so that, in fact, the funiculi composing a single nervous trunk have an arrangement with respect to each other similar to what we find to hold in a plexus formed by the branches of different nerves. It must be distinctly understood, however, that in these communications *the proper nerve fibres do not join together or coalesce.* They pass off from one nervous cord to enter another with whose fibres they become intermixed, and part of them thus intermixed may again pass off to a third funiculus, or go through a series of funiculi and undergo still further intermixture. But through all these successive associations, the nerve fibres remain, as far as known, individually distinct, like interlaced threads in a rope.'

'*Vessels.*—The blood vessels of a nerve, supported by the nerve sheath, divide into very fine capillaries, said by Henlé to measure in the empty state not more than $\frac{1}{6000}$th of an inch in diameter. These, which are numerous, run parallel with the funiculi, but are connected at intervals by short transverse branches, so as, in fact, to form a network with very long narrow meshes.

'*Branching and Conjunction of Nerves.*—Nerves in their progress very commonly divide into branches, and the branches of different nerves not unfrequently join with each other. As regards the arrangement of the fibres in these cases, it is to be observed, that, in the branching of a nerve, portions of its fibres successively leave the trunk and form branches; and that when different nerves or their branches intercommunicate, fibres pass from one nerve and become associated with those of the other in their further progress; but in neither case (unless at their peripheral terminations) is there any such thing as a division or splitting of an elementary nerve into two, or an actual junction or coalescence of two such fibres together.'—SHARPEY; QUAIN, Introduction, clxxxiv-vii.

'*Origins or Roots of the Nerves.*—The cerebro-spinal nerves, as already said, are connected by one extremity to the brain or to the spinal cord, and this central extremity of nerve is, in the language of anatomy, named its origin or oot. In some cases the root is single, that is, the funiculi r fibres by which the nerve arises are all attached at one pot, or along one line or tract; in other nerves, on the conrary, they form two or more separate collections, which arise part from each other, and are connected with different parts f the nervous centre, and such nerves are accordingly said o have two origins or roots. In the latter case, moreover, he different roots of a nerve may differ not only in their natomical characters and connexions, but also in function, as s well exemplified in the spinal nerves, each of which arises y two roots—an anterior and a posterior; the former conaining the motory fibres of the nerve, the latter the sensory.

'The fibres of a nerve, or at least a considerable share of them, may be traced to some depth in the substance of the brain or spinal cord, and hence the term "apparent or superficial origin," has been employed to denote the place where the root of a nerve is attached to the surface, in order to distinguish it from the "real or deep origin," which is beneath the surface and concealed from view.

'To trace the different nerves back to their real origin, and to determine the points where, and the modes in which their fibres are connected with the nervous centre, is a matter of great difficulty and uncertainty; and, accordingly, the statements of anatomists respecting the origin of particular nerves are, in many cases, conflicting and unsatisfactory. Confining ourselves here to what applies to the nerves generally, it may be stated, that their roots, or part of their roots, can usually be followed for some way beneath the surface, in the form of white tracts or bands, distinguishable from the surrounding substance; and very generally these tracts of origin may be traced towards deposits of grey nervous matter situated in the neighbourhood, such, for instance, as the central grey matter of the spinal cord, the grey nuclei of the pneumogastric and glossopharyngeal nerves, the corpora geniculata (attached to the corpora quadrigemina), and other large grey masses connected with the origin of the optic nerve. It would further seem probable, that certain fibres of the nerve roots take their origin in these local deposits of grey matter, whilst others become continuous with the white fibres of the spinal cord or encephalon, which are themselves connected with the larger and more general collections of grey matter situated in the interior or on the surface of the cerebro-spinal axis. There is still much uncertainty as to the mode in which the nerve fibres, originating or terminating in the grey matter, are related to its elements, and, for the most part indeed, individual fibres, on being traced into the grey matter, become so hidden in the mass as to elude further scrutiny. Some anatomists have maintained that the fibres form loops or slings, which lie in the grey substance, but have apparently no organic connexion with its elements. According to others, the nerve fibres arise from the caudate nerve cells, being prolongations of the filamentous processes issuing from these bodies, which, after proceeding a little distance from the cell, acquire the character of tubular fibres. It has been already stated that nerve fibres are connected in this way with the cells of the ganglia, and the testimony of many competent observers leaves no room to doubt that this is at least one mode in which the nerves are connected with the grey matter in the cerebro-spinal centre.'—Id. clxxxviii.-xc.

'*Termination or Peripheral Extremity of Nerves.*—The results of modern microsopic discovery seemed for a time to lead to the conclusion that the fibres of nerves do not, strictly speaking, end in the tissues in which they were distributed, but merely dip into those tissues, as it were, and, after forming slings or loops of greater or less width, return sooner or later to the nervous trunks. The further progress of inquiry has, however, shown—*First*, that the disposition of their elementary fibres in terminal loops, or in terminal plexuses through which they return again towards the parent trunks, is by no means general: that, as far as known, they more commonly end by simply truncated, or slightly swollen extremities, as in the instance of those entering the Pacinian bodies, or become gradually lost to the sight in the surrounding tissue, usually after considerable reduction in size, and after laying aside their dark outline, probably from privation of their white substance. That even where, apparently, terminal loops are observed, it is difficult to say whether these may not in some cases be caused by serpentine windings in the fibres previous to their actual termination, which may itself be hidden from view. *Secondly*, that elementary nerve fibres, although, as far as is known, they keep entire and distinct in their course along the nerves, do in various instances actually divide into branches, and in some cases unite or inosculate with each other, in approaching their termination. *Thirdly*, that in certain cases the fibres of nerves come into near relation at their peripheral extremities with cells resembling the nerve cells of the brain and ganglia.'—Id. ccxvi., ccxxiv.

Thus in comparing the termination of the blood vessels with the termination of the nerves, we find a dissimilarity or contrast, indicating some radical difference in the way that the two very different influences, blood and nervous force, are brought to bear upon the various tissues. In the case of the circulation of the blood, the arteries are seen to subdivide till they reach their smallest ramifications in the capillaries, which capillaries are in contact with the tissues, and supply nourishing material through their coats or walls, by an oozing or sweating process; the stream passes on through the capillaries without interruption into the veins, where it is accumulated by flowing from the smaller branches into the larger, and at length reaches the heart; being thus kept in close channels large or small through the entire circuit of the body. But although the nerves are arranged on the plan of carrying one influence outward, and bringing another back from the same spot, the distinct sets of nerves used for the two purposes, do not join or become continuous at their extremities like arteries and veins; they seem rather to terminate absolutely and apart in the tissues; instead of a self-contained circuit, the course is broken or interrupted by the muscular, mucous, or other tissue where they end. This break is an important fact in the nervous structure; for although as yet we may not be able to trace the full meaning of it, it furnishes several instructive suggestions; and we shall probably avail ourselves of these in some of the discussions that are afterwards to occupy our attention.

FUNCTIONS OF THE NERVOUS SYSTEM.

10. Hitherto we have restricted our attention to the structure and arrangement of parts in the nervous mechanism: including under that head the central masses and the ramifying threads or cords passing between the centres and the various regions of the body. The functions, uses, or mode of operation, of those centres and ramifying cords have now to be considered. The experimental enquiries of recent years have thrown much light upon this obscure and mysterious subject; and the microscopic investigation of the nervous substance, from which we have obtained our knowledge of the distinctive structure of the grey and the white matter, has tended greatly to simplify the study of nervous action. Reversing the order observed above in the description of structure, I shall take up the subject of function, first, as regards the Nerves, and next, as regards the Nerve Centres.

Functions of the Nerves.

11. The Nerves are divided into two classes according as they proceed from the Spinal Cord, or issue direct from the brain. The first class, called the Spinal Nerves, is the most numerous. It is not implied that these nerves have no connection with the brain, but merely that their place of emergence or 'superficial origin' is in the Spinal Cord. The arrangement is to be looked upon as a matter of local convenience. The nerves destined for the lower limbs do not leave the general trunk until they approach the neighbourhood that they are to supply; that is, they are prolonged within the spine to its lower extremity; whilst those branching towards the arms emerge in the neck and between the shoulders. On the other hand, the nerves that supply the face and head leave the brain at once by openings in the skull; these are the Cerebral Nerves. There is no snbstantial difference of nature between the two classes.

In the mode of junction of the Spinal Nerves with the

Spinal Cord a peculiarity is observed of great importance in the present subject. I have already noticed the fact that they issue from the spine in pairs, one pair between every two vertebræ; there are in all thirty-one couples. Each couple contains a right and a left member, for distribution to the right and left sides of the body. This part of the arrangement is likewise a matter of local convenience. But, further, when one individual of these emerging couples is examined, say a right branch, we find that this branch does not arise from the cord single; it springs from two roots, and these after proceeding apart for a short way, unite in the one single nerve that is seen to issue from between the vertebræ on the right side. The same holds of any left branch that may be fixed upon; the connection with the cord is not single, but double. The smaller of the two roots in each case proceeds from the fore part of the cord, and is called the *anterior* root; the other or larger proceeds from the hinder portion of the cord, and is called the *posterior* root. This last root, the posterior, is distinguished in another point, besides its greater size. Just after leaving the cord there is a ganglion or little swelling formed upon it, this ganglion being composed in part of grey matter, and being to appearanee of the nature of a nerve centre. Beyond the ganglion, the two roots mingle and constitute the one nerve seen to emerge from the spine.*

12. Having thus noticed two classifications of the Nerves, the one—into Spinal and Cerebral—unimportant as respects function, the other—into anterior and posterior roots—highly important, as will be seen; we now proceed to state what the function or use of a nerve is. *The function of a nerve is to transmit impressions, influences, or stimuli, from one part of the system to another.* The nerves originate nothing; they are exclusively a medium of communication; they have the carrying function. It is not easy to describe the nature of the influence that passes along the various spinal and cerebral ramifications; but whatever that influence be, we do not find

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* See Fig. 2, p. 18.

it to be generated in the fibrous bundles of the nerve substance, nor can it be absorbed there. Hence the term '*conductor*' applied to the lines of nerve passing to and fro throughout the body. We know of no other mode of employing a nerve thread than in conduction; and whatever may be the operations that any branch or twig is concerned in maintaining, the part performed by it consists simply and solely in carrying an impulse, given to it at one extremity, onwards to the other extremity. Neither feeling nor action will start up at any point on the line of a nervous bundle; but through the instrumentality of transmission, every nerve may be the means of causing either the one or the other.

The experimental proofs of this position are numerous, and they are now reckoned conclusive. If a main trunk nerve supplying a limb be cut through, all sensation in the limb ceases, and also all power of movement. Dissevered from the centres, it has no influence. The blood circulates and the parts are nourished, but for the purposes of feeling or action the member is excommunicated, dead. The telegraph wire is cut.

If, instead of cutting the nerve through, we prick or irritate it, an influence is generated and is made to appear by causing both feeling and movement. Whether the irritation is applied high or low, near the nervous centres or near the extremities of the body, the effect is precisely of the same nature. The pricking originates an impression or stimulus, which the nerve conveys through its whole length; wherever that nerve ramifies, in each place do we note feeling or movement, or both. The nerve neither begins nor swallows up the influence; but carries forward and discharges it. It appears, however that the influence, *increases* as it passes along the nerve, presenting a marked contrast to the conduction of electricity by a wire, for the electric current diminishes by transmission. The nerve is not a passive, but an active conductor.*

* It seems singular that such an action as pricking a nerve with the point of a needle, pinching it, electrifying it, dropping pungent liquids upon it,

13. The property of communication or conduction, the exclusive function of the nerve threads, belongs to all the fibrous masses, that is, to the *white matter* of the nervous system. The conveying structure is the fibrous; a different function is reserved for the grey matter, as we shall presently see,—that of originating influence. Every separate fibre is a wire, and carries its own independent stimulus, although bound up with thousands of other fibres in the same cord or tract. Wherever white matter exists, lines of communication are established. We recognise lines of conduction or transmission not only between the remote organs of the body and the cerebro-spinal centre, but also throughout the different parts of the encephalon and spinal cord; in other words, we must admit the existence of currents and counter currents in the interior of the brain itself. All those connecting bands of fibres, or white substance, known as peduncles of the cerebrum and cerebellum, the commissures of the cerebrum, and all the white matter in the interior of the hemispheres underneath the convolutions, must be looked upon as em-

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should set a-going the same kind of influence as comes from its own proper centres. But this is from the peculiarity of the nerve, and not from any identity between the influence of a nerve centre and the influence of a mechanical irritation, electrical action, or chemical corrosion. A nerve is so constituted that it will carry one set of influences and no other. If we are able to disturb it at all, so as to propagate any kind of influence, this will be the influence that the nerve is accustomed to propagate. It will be an influence either setting some part in motion, or producing sensation somewhere. Because we burn it with an acid at one point, it will not therefore convey to the extremities a corroding influence, as if acid were poured out at the end of every fibre; it will simply cause either a convulsive action of the muscles, or a strong sense of pain in the parts where its terminations lie. The fibres are formed to transmit a peculiar and distinct influence, and they will either take on the bent requisite for transmitting that influence, or remain dormant. It so happens, however, that the substance of nerve is extremely susceptible, and very readily falls into the active propagating attitude; whence influences very unlike those coming from the proper sources of influence may disturb the quiescent condition and set on the very current belonging to the legitimate stimulus. This gives to the fibrous substance of nerve, not an originating, but a *determining power;* it will take on only one kind of influence, only one sort of message will be carried by it.

ployed in receiving influences from one nervous centre or portion of the cerebral mass, to discharge them in another.

14. We have remarked of the nerves that they convey influence for the two distinct ends of causing action and of causing feeling. For action, the influence must proceed outwards from the centres to the active organs; a stimulus from the brain or spinal cord has to be transmitted to the limbs, trunk, head, eyes, mouth, voice, or other parts that are to be set in motion. For feeling, the influence must pass inwards. In a sensation of hearing, for example, an impression made on the sensitive surface of the ear is conveyed by the nerve of hearing towards the cerebral centres. Now it is found that different sets of nerves are employed for those two purposes; one class being exclusively devoted to the outward transmission of stimulants to action or movement, while the other class is equally confined to the office of conveying influence centrewards, for the ends of sensation or feeling. The first of these two classes is that named *efferent* (out-carrying) nerves, the second comprises the *afferent* (in-carrying) nerves. In every individual fibre it would appear that the influence always follows one direction. No single nerve can combine both functions.

It is further known, since the discovery of Sir Charles Bell, that one of the two roots of the spinal nerves is entirely composed of nerves conveying the outward stimulus; these are, therefore, purely nerves of motion, '*motor* nerves.' The other root consists of fibres transmitting influence from the various parts of the body inwards to the centres; these are called the *sentient* nerves. (They are not all sentient in the full sense of the word, as will be afterwards explained.) The anterior roots are the motor nerves; the posterior roots are the in-carrying or afferent nerves. On these last roots, the posterior, the ganglionic swellings occur; and both in the spinal nerves and in those emerging at once from the brain by openings in the cranium, the occurrence of a bead is a proof that the nerve is of the in-carrying or sentient class.

In the experiments above described as made upon trunk nerves of an arm or leg, effects both of movement and sensation were seen to follow; the limb was thrown into convulsive movements, and the animal showed all the symptoms of being in bodily pain. If, now, instead of a main trunk, the trial is made upon one of the roots of a spinal nerve, only one single effect will be produced,—motion without sensation, or sensation without motion of the part. If an anterior root is pricked or irritated, movements of some part of the body will follow, showing that an active stimulus has been discharged upon a certain number of muscles. If a posterior or ganglionic root is pricked, the animal will show symptoms of pain, and the pain will be mentally referred to the part where the filaments of the nerve are distributed. If the nerve is one proceeding to the leg, there will be a feeling of pain in the leg; but there will be no instantaneous convulsions and contractions of the limb, such as are produced by irritating an anterior root. All the movements that an animal makes under the stimulus of a sentient root, are consequent on the sensation of pain; they are not the direct result of the irritating application. In one of the trunk nerves of an arm or a leg, both motor and sentient fibres are mixed up, which is the reason of the mixed effect in the first experiment above mentioned.

15. Experiments with pure nerves, that is, with motor fibres alone, or sentient fibres alone, are best made upon the nerves of the head,—the Cerebral Nerves. A certain number of these are exclusively motor, certain others are exclusively sentient, while a third kind are mixed, like the spinal nerves beyond the point of junction of the two roots.

The Cerebral Nerves are divided into nine pairs, some of these being considered as admitting of farther subdivision. *Four* are enumerated as nerves of pure sensation:—the nerve of smell (olfactory nerve, 1st pair); the nerve of sight (optic nerve, 2nd pair); the nerve of sensation of the tongue and face generally (5th pair); this nerve contains also a motor portion distributed to the muscles of mastication; the nerve of hearing (auditory nerve, part of the 7th pair). These

Nerves, therefore, are exclusively engaged in transmitting influence from the surfaces of special sense, the nose, eyes, ears, tongue, and face, towards the cerebral mass. *Five* nerves are enumerated as purely motor or out-carrying:—the nerve supplying three of the four recti (or rectangularly arranged) and one of the oblique muscles of the eye, and sustaining its ordinary movements (*motor communis oculorum*, 3rd pair); the nerve supplying the superior oblique muscle of the eye (*trochlearis*, 4th pair); the nerve distributed to the external rectus muscle of the eye, and serving to abduct the two eyes by an independent stimulus requisite in adjusting the eyes to different distances (*abducent*, 6th pair); the trunk nerve for setting on the movements of the face and features (2nd part of 7th pair); the nerve for moving the tongue (9th pair). The pair reckoned the 8th, consists of sensitive fibres distributed to the tongue, throat, lungs, and stomach, and also of motor fibres distributed to muscles.

If any one of the four sensitive nerves issuing from the cranium be cut through, sensation in the connected organ is lost; disease will produce the same effect. Injury in the optic nerve causes blindness, in the auditory nerve deafness. If any one of them is irritated by pricking, corrosion, or electricity, a sensation is produced of the kind proper to the nerve; if the olfactory nerve, a smell is felt; the optic, a flash of light; the auditory, a sound; but no movement is generated. If any one of the five motor pairs is cut, the corresponding muscles cease to act; they are said to be paralysed, an effect also produced by nervous disease. If the third pair were cut, the motion of the eyeballs would cease, there would no longer be any power of directing the gaze at pleasure, the most brilliant spectacle would fail to command the sweeping glances of the eye. If the moving portion of the 7th pair were cut on one side, all the muscles of the face on that side would lose their tension, and the equipoise of the two sides being thus destroyed, the face would be set awry, by the action of the unparalysed muscles.

By experiments of this nature the functions of the several cerebral nerves have been successively ascertained. In like manner, the discovery of Sir Charles Bell, as to the compound nature of the spinal nerves has been fully confirmed. It has been shown beyond the possibility of doubt, that the nerve fibres are of two distinct classes, with different functions, and that the same fibre never serves both functions; that a current peculiar to each fibre sets in always in one direction; and that nothing beyond a conducting character ever belongs to the nerve bundles, or to the fibrous aggregates, the white substance, of the cerebro-spinal system.

Functions of the Spinal Cord and Medulla Oblongata.

16. We have now to speak of the Centres, or the masses that make up the cerebro-spinal axis,—the brain and spinal cord. These central masses all contain grey substance, the cellular or vesicular matter, wherein the nerve fibres are known, in some cases if not all, to terminate. None of them is exclusively composed of grey matter, for within the boundaries of each mass a quantity of the communicating fibres occur. But their peculiar or distinctive character is imparted by the grey substance that they contain. By setting forth the ascertained functions of these masses in succession, we shall arrive at some notion of the powers and properties of the grey matter, just as in discussing the nerve fibres we have obtained a knowledge of the use of the white substance, whether in the nerve ramifications, or in the interior of the centres.

17. With regard to the Spinal Cord, we find, in the first place, that it is necessary to sensation and to voluntary movement (movement from feeling) throughout the entire trunk and extremities of the body. If the cord is cut across at any part, all feeling is lost, and all power of movement by the will, everywhere below that place, or in every portion of the body where the nerves arising beyond the cut are distributed. If the division is made far down in the back, the lower limbs are the parts principally paralysed; from them feeling comes no more, nor is it possible to move them by

any mental effort. If the cut is in the neck, the arms, trunk, and legs are alike paralysed. It becomes evident, that the continuity of the cord with the brain is necessary, in order to connect the mental system with the bodily members. The cord by itself will not give the power either of sensation or of voluntary movement. We must regard this portion of the cerebro-spinal axis as a main channel of nervous conveyance for sensation and voluntary action, between the brain, and the trunk and the extremities of the body. The nerve ramifications are here, as it were, gathered together into one rope or bundle, for convenient transmission to and from the masses of the encephalon. To this extent, the cord is not a centre, but an assemblage of the general mass of ramifying or communicating fibres; we may look upon it as the trunk of the tree, the final stream of the river system.*

If now we make experiments upon the cord when dissevered from the brain, we discover that a power of producing

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* Dr. Brown-Séquard has determined by decisive experiments that the transmission of sensitive impressions, in the spinal cord, takes place chiefly through the *grey* matter, and partly through the anterior columns; the impressions being conveyed to the grey matter by fibres passing obliquely across the posterior columns. The singular part of this doctrine is the attributing of a conducting function to the grey matter; and, although the grey substance of the cord contains white fibres, these are comparatively few in number, and the conclusion seems inevitable that a line of nervous communication is maintained by the vesicles of the cord and their connecting fibres. The communication with the brain was maintained after cutting through the white columns, provided the grey substance remained intact.

The posterior columns of the cord contain the fibres proceeding from the nerves to the grey substance; these fibres pass obliquely upwards and likewise obliquely downwards, before reaching the grey substance; they also have a great share in reflex movements, that is to say, they contain a large number of the fibres that do not communicate with the brain, but begin or end in the cord.

Dr. Brown-Séquard has also established the fact that the nerves engaged in conducting sensitive impressions from the trunk and limbs *decussate* in the spinal cord, and not, as had been formerly supposed, after they reach the brain. By decussation is meant the passing to the side of the spinal cord or of the brain opposite to that where they enter. This arrangement gives rise to the singular phenomenon of disease in one side of the brain causing loss of feeling in the members of the other half of the body.

movements, though not voluntary, still remains. On irritating any portion of the substance, movements of the limbs are observed. This effect might, no doubt, arise from the continuity of the part with some of the motor nerves; for we have seen that movements in a limb are caused by pinching one of the nerves that supply the limb. But there is a mode of trying the experiment so as to prove decidedly that the spinal cord is itself a source of movement; that is, to prick the skin of the toes; when this is done we find that a convulsive stimulus instantly returns upon the limb and throws it into action. Hence we infer that an impression arising on the surface of the body and conveyed to the spinal cord, but not to the brain, causes the cord to send forth a motor stimulus to the moveable organs, a phenomenon, moreover, that ceases on the destruction of the cord.

'In most instances where the spinal cord has been divided, whether by design or accident, it has been found that although the will cannot move the paralysed parts, movements do occur in them of which the individual is unconscious, and which he is wholly unable to prevent. These take place sometimes as if spontaneously, at other times as the effect of the application of a stimulus to some surface supplied by spinal nerves. The apparently spontaneous movements frequently resemble voluntary actions so closely, that it is almost impossible to distinguish them.'

'The following experiments serve to illustrate these actions :—

'If a frog be pithed by dividing the spinal cord between the occipital hole and the first vertebra, an universal convulsion takes place while the knife is passing through the nervous centre. This, however, quickly subsides; and, if the animal be placed on the table, he will assume his ordinary position of rest. In some exceptional cases, however, frequent combined movements of the lower extremities will take place for a longer or shorter time after the operation; when all such disturbance has ceased, the animal remains perfectly quiet, and as if in repose, nor does there appear to be the slightest expression of pain or suffering. He is quite unable to move by any voluntary effort. However one may try to frighten him, he remains in the same place and posture. If now a toe be pinched, instantly the limb is drawn up, or he seems to push away the irritating agent, and then draws up the leg again into its old position. Sometimes a stimulus of this kind causes both limbs to be moved violently backwards. A similar movement followes stimulation of the anus. If the skin be pinched at any part, some neighbouring muscle or muscles will be thrown into action. 'Irritation of the anterior extremities will occasion movements in them: but it is worthy of note that these movements are seldom so energetic as those of the lower extremities.'—TODD and BOWMAN, I, 308-9.

These experiments prove beyond a doubt that a circle of nervous action is completed by the spinal cord in its isolation from the brain. It is manifest that the in-carrying nerves must be in communication with out-carrying or motor nerves, in the interior of the spinal substance, a communication that renders the cord, to all intents and purposes, a *nerve centre,* and not merely an aggregate or bundle of nerve conductors. This property of sending out motor power is believed to depend upon the grey matter that is enclosed in the cord; for no reflex force is ever shown without the intervention of a certain portion of grey substance; and such reflected power is more energetic as the grey or vesicular matter exists in larger quantity. The cord is therefore one of the power-originating portions of the nervous system; and investigation has determined pretty accurately what kind of power it yields, and for what purposes in the animal economy. I shall here present a brief summary of the principal active functions sustained or assisted by the central energy lodged in this part.*

* It is a curious fact that the effects produced by irritating the nerves and spinal cord are not repeated in the white or the grey substance of the hemispheres. Neither sensation nor movement appears to result from pricking the cerebral lobes. This shows a marked difference of character between the two kinds of nerves. An explanation of this difference is offered in the discovery that the spinal cord consists of two classes of motor fibres, one employed in conveying the impulses of the will, and not excitable by external

18. In describing the functions of the cord it is convenient to include the Medulla Oblongata, with which the cord is continuous in structure, and which is found to possess the same essential characters. As a centre the Medulla originates and sustains movements independent of the cerebrum; those movements need not the stimulus of feeling nor that exertion consequent upon feeling, that we term volition. By classing the spinal cord and medulla oblongata together, and comprehending along with these the corpora quadrigemina and pons Varolii, and studying this aggregate apart from the rest of the brain, we seem to draw a broad line—the broadest that can be drawn anywhere within the cerebro-spinal axis, between the seat of stimuli and actions without feeling, and the seat of stimuli and actions with feeling; between the involuntary and the voluntary—between body and mind. The actions maintained by the cord and medulla oblongata resemble many of the true mental actions; they actuate the same muscles, the same moveable parts, but inasmuch as they do not require feeling as an indispensable condition of their performance, they are excluded from the province marked by our definition of mind. They are termed *automatic* or self-moved actions, and also *reflex* actions. The enumeration of the functions of the cord will be an enumeration of this class of actions which seem to be mental but are not.

(1.) Movements connected with the process of *Digestion*. This process requires a series of movements to be kept up for passing the food along the different stages of the alimentary canal, to undergo its various changes there. The first operation upon the food in the mouth—the chewing or masticating—is voluntary, and requires the stimulus of the brain.

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irritation, the other opposed to these in both points. Dr. Brown-Séquard thinks that the last are reflex-motor merely; they abound in the centres of reflex movement—the spinal cord, medulla oblongata, &c. The voluntary motor fibres must needs pass through those centres and proceed to the cerebral lobes, or at least to the corpora striata. It may be, therefore, that the unirritable fibres of the hemispheres, proceeding downwards and conveying the stimulus of the will, remain unirritable all throughout to the extremities of the body.—*Lectures on the Nervous System*, p. 242.

On passing to the back part of the tongue, the food enters the bag of the throat, or pharynx, and is thence projected down the gullet by contractions and movements that are involuntary; the mind has no control over them, and scarcely any feeling or consciousness of their taking place. These movements are due to the medulla oblongata. The contact of the food with the surface of the throat makes an impression on certain nerves distributed on that surface; these nerves transmit an influence to the medulla oblongata, and there returns a stimulus to the muscles of the pharynx, which muscles are in connexion with the same centre through motor nerves. In this manner, the food is propelled onwards by the muscular contractions of the tube, and enters the stomach. The mind is utterly excluded from participation in this effect, being unable either to assist or retard the progress of the mass, and, except at the two extremities, being hardly aware of the stage that is reached at any moment. This function illustrates what is often said of the medulla oblongata and the cord, that they give birth to the movements necessary for keeping up the organic processes.

(2.) Connected with the *Respiration*, there are certain reflex, or automatic, movements. The action of breathing is performed by means of a number of muscles, but these, unlike the muscles of the alimentary region, are also the instruments of the will in voluntary operations. The muscles of the chest and abdomen are employed in the acts of breathing; in taking in breath, the lungs are expanded by the muscles of the chest, and in expiration the abdominal muscles contract the chest and force out the contained air. This action goes on whether we wake or sleep, being involuntary, and the seat of power in this case is found to be in part in the medulla oblongata. There passes to and fro, between the muscles and the grey matter of the medulla, a nervous stimulus; the two opposing sets of muscles are acted on by turns, and an alternating movement is thus kept up from the first moment of drawing breath to the last. There is more here than a simple reflex stimulus, such as described in the actions of a pithed frog. The case is not one where irritation or contact with a surface excites a single group of muscles in one way, as when the frog's limb is drawn up on the pinching of the toe. We have a higher complication, a stage in advance towards *combined and regulated action*, the kind of action that attains its highest pitch under the mental organization, being developed to some small extent within the automatic, or spinal system. Indeed, in the propulsion of food, there is a compound or double action, a contraction along the length of the gut with a contraction of the thickness, and this action follows a certain order or rhythm so as to move the food always in one way; but in breathing, the compound action is of a more decided and palpable kind; the two acts are opposed to each other, and must take place by turns. The commencing stimulus in this case requires to be a muscular stimulus, an effect arising out of the action of muscles, and not the irritation or compression of a surface. The completed action, the fully accomplished contraction, of one set of muscles must affect the centre so as to commence the action of the other set. There would require to be distributed to the same muscles two classes of nerves, one for conveying influence inward to the medulla oblongata, the other for receiving the motor stimulus arising there; and the circles would require to be so organised, that the nerves conveying influence inward from the muscles of inspiration, should pass to those portions of the grey substance of the medulla that send out motor nerves to supply the muscles of expiration; and, conversely, the ingoing nerves from the last named set should be in relation with the motor nerves belonging to the other set, those of inspiration; while the stimulus proper to these incarrying nerves—the influence that they are adapted to convey—should be that arising from the full and complete contraction of their respective muscles. Such is the arrangement that we are at liberty to assume or suppose, in order to account for the double action. It is important for us to recognise this mode of mechanism in this its simplest example, as we shall have reason for believing that the same mode prevails extensively throughout the bodily and mental constitution.*

There are certain special movements, occasionally executed by the respiratory apparatus, likewise belonging to the automatic or reflex class. *Coughing* is one of those. The stimulus in this case, however, is a true surface stimulus; the contact of foreign matter with the interior wall of the bronchial tubes is the cause of the spasmodic movement. The irritation of the bronchial surface originates a stimulus propagated to that part of the medulla oblongata that sustains the action of the lungs. The consequence is a momentary increase of the expiratory force, the glottis being closed and opened suddenly, so as to amount to an explosion, or a shot, which propels the material out of the tube. The action of the lungs is peculiarly liable to be raised to this explosive pitch, owing, we may suppose, to the readiness of the medulla oblongata to give off sudden discharges of central energy. *Sneezing* differs from coughing in the circumstance that the seat of irritation is the nose. The course of the explosive current is on that account directed through the nostrils.

Among the reflex influences exerted upon the lungs through spinal intervention, we are to include the stimulus

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* When the sensory nerve distributed to the surface of the lungs is cut through, the breathing action is weakened, showing that a certain amount of stimulus is derived from the action going on throughout the surface. If, farther, the brain is paralyzed by any poison, the respiration is still more enfeebled, leading us to infer that the brain contributes to the breathing activity. Dr. Brown-Sequard has been led, by the examination of a great many cases, to the conclusion that the whole base of the brain is employed in respiration. He says:—'All the facts just mentioned, and many others have led me, first, to abandon the view so generally admitted, that the medulla oblongata is the essential source of the respiratory movements in the nervous centres; and, secondly, to propose the view that these movements depend upon the *incito-motory* parts of the cerebro-spinal axis, and on the grey matter which connects those parts with the motor nerves going to respiratory muscles. The chief stimulus to respiration is the action on the surface of the lungs, but 'excitations from all parts of the body (as by cold, for instance), and also direct irritations of the base of the brain and of the spinal cord, almost constantly taking place, contribute to the production of respiratory movements.'—*Lectures*, p. 192.

of cold suddenly applied; which stimulus acting on the surface of the lungs in the shape of cold air, or on any part of the skin, as in the cold bath, reinforces the breathing energy. This influence is accompanied with a very keen sensation, but the instantaneous reaction that increases the movement of the lungs, is believed to be entirely independent of sensation or of will, and is attributed with appearance of reason to the medulla oblongata. The hysteric laugh, which is one of the effects of cold, points to the mediation of the medulla even in the effects arising from the sensation.

(3.) The *winking of the eyes* is essentially automatic. Although not entirely withdrawn from the control of the mental centres, this movement of the eyelids usually goes on independent of these centres. The stimulus to the movement is a surface stimulus, apparently due to the liquid that washes the eye, thereby coming in contact with the inner surface of the upper eye-lid. When an action takes place on this inner surface, an influence is transmitted inwards to some centre,* and there is reflected a stimulus to the muscle that closes the lids. One may try the experiment by touching the edge or inner surface of the upper eye-lid with anything solid; instantly there is produced a spasmodic flutter of the eye-lid, or a very rapid succession of winks. The reflex act goes to closing the eye, and the opening is effected by the muscles that keep the eye open during the ordinary waking state. In sleep, the winking muscle is unresisted and keeps the eyes shut. The activity of this muscle, (called the orbicularis) is shown by this fact to be purely reflex, for no voluntary movement is sustained when we are asleep. The movements of the iris are also reflex movements, and depends on the spinal cord.

4. It is to be considered how far the *muscular movements generally*, the locomotive and other actions of the body at large, are sustained by the spinal cord. We have already seen that convulsive movements of the limbs can be excited in

* Probably the medulla oblongata.

a decapitated animal; and the question arises, does the cord keep up any of the regulated motions of the animal body, such as walking, running, flying, swimming, &c. The answer is that the cord does not seem capable of maintaining these motions. For, although there exists an innate power of performing them in many cases, other centres besides the cord are essential to their performance. In fact, the cerebellum is looked upon as the centre of the higher order of combined actions, notwithstanding that one pair of alternating movements, as in breathing, can be kept up by the cord alone The locomotive movements of animals immediately after being decapitated, are not a proof of the power of the cord acting by itself, inasmuch as these may be owing to the yet unexhausted stimulus of the brain, or they may be actions induced upon the cord, in consequence of habit.

There is one instance of muscular action by most physiologists ascribed to the spinal cord, and believed to have a peculiar interest in this point of view; that is, the *tension. tone*, or *tonicity* of the muscles. By this is meant the fact that a muscle is never wholly relaxed while the animal is alive. Even in the perfect repose of sleep, there is yet a certain vigour of contraction inhering in all the muscles of the body. The force of contraction is increased at the moment of wakening, and still more when an effort is to be made, but at no time is the relaxation total; the limbs never dangle like a loosely constructed doll until after the animal is dead. Now there is a certain amount of this permanent contractile force fairly ascribable to the muscle's own vitality, apart from any nerve stimulus whatever. For we are not to suppose that the contractility of muscle is wholly dependent on the conveyed influence of nerve centres; whence there is some difficulty in ascertaining how much of the effect is derived and how much inherent.

The experiments relied upon for showing that the permanent tension of the muscle is in part due to spinal influence, are very striking and not easily explained away. I quote from Dr. Carpenter: 'It has been proved by Dr. Marshall Hall that the muscular Tension is not dependent on the influence of the Brain but upon that of the Spinal Cord, as the following experiments demonstrate: 'Two Rabbits were taken: from one the head was removed; from the other also the head was removed, and the spinal marrow was cautiously destroyed with a sharp instrument: the limbs of the former retained a certain degree of firmness and elasticity; those of the second were perfectly lax.' Again: 'The limbs and tail of a decapitated turtle possessed a certain degree of firmness and tone, recoiled on being drawn from their position, and moved with energy on the application of a stimulus. On withdrawing the spinal marrow gently out of its canal, all these phenomena ceased. The limbs were no longer obedient to stimuli, and became perfectly placid, having lost all their resilience. The sphincter lost its circular form and contracted state, becoming lax, flaccid, and shapeless. The tail was flaccid.'—(Carpenter, p. 700). Here we see that the disconnecting of the muscles from the brain still leaves them in a tense condition, while that tension gives way the instant the spinal cord is removed. A current of nervous stimulus is thus shown to be perpetually derived from the cord to the muscles in connection with it; any impression made upon the surface or extremities of a limb, suddenly increases this current in some one direction, but does not create it entirely. We are therefore led to infer, that the nerve centres of the spine have in them a constant charge of nervous energy, which flows out at all times, a force originating there independently of the stimulus of outward impressions, although more copiously manifested under such outward stimulus. This is an extremely important fact whichever way we view it, and one that will again force itself upon our notice.

So much for Reflex actions and the Functions of the Spinal Cord.

Functions of the lesser grey centres of the Brain.

19. The principal bodies of the nature of centres situated between the medulla oblongata and the convoluted hemi-

spheres of the brain, have been already enumerated. There are four masses of conspicuous size and position, the pons Varolii, the corpora quadrigemina, the thalami optici, the corpora striata.

The *pons Varolii,* with the crura cerebri, is in part to be viewed as the continuation of the spinal cord to the brain. Its integrity is essential to sensation and volition. Considered as a centre, Dr. R. B. Todd has given arguments to show its connection with the emotional movements, and Dr. Brown-Séquard considers that it shares this function with the medulla oblongata, of which it is the immediate continuation. Laughter, sobbing, and the excitement of the framework under strong feelings, are stimulated directly from these organs, although we must suppose a more remote cause of excitement in the convoluted hemispheres. If one of the crura cerebelli (surrounding the pons) is cut close by the pons, the animal rolls round its axis towards the injured side; if it is cut higher, the rolling takes place towards the uninjured side. If both are cut through, the motion of the body is greatly weakened. Every injury of these crura makes a change in the position of the eyes: the eye on the injured side turns outwards and downwards, that on the sound side inwards and upwards.

The *corpora quadrigemina* are intimately connected with vision. They give origin to one root of the optic nerve. Their destruction causes blindness. They are the centres of the reflex motions of the eye stimulated through the optic nerve and the muscles of the eye.

The *corpora striata* and *thalami optici,* according to Dr. Brown-Séquard, are centres of voluntary movements. This must doubtless be qualified by the statement that the convoluted hemispheres also participate in these movements. When the corpora striata are cut or wounded the sensation of touch is lost, the feeling of pain remaining; the initiative of voluntary movements is abolished, although regular movements can be maintained if once commenced. The animal neither begins nor ceases to move of its own accord.

Dr. Todd and other physiologists have regarded the thalami optici as centres of sensation, or of the sensitive nerves; but, according to Dr. Brown-Séquard, anatomy and pathology are opposed to this view.

Functions of the Cerebral Hemispheres.

20. The convoluted hemispheres of the brain enclose within them the above-mentioned masses or centres, and both the convolutions and these centres are included in the cerebrum. Experiments have been made with a view of determining the characteristic functions of this cerebral mass, so large in the human brain, although dwindling to the most insignificant dimensions in the lowest vertebrate animals, namely, reptiles and fishes.

The convolutions are the portion most accessible to operations. The hemispheres have been seen above to consist of an outer layer of convoluted grey matter, and an interior mass of white, fibrous, or connecting matter. When irritation is applied to the hemispheres, as by pricking or cutting, we find a remarkable absence of the effects manifested in the other centres. Neither feeling nor movement is produced. This marks a very great distinction between the hemispheres and the whole of the ganglia and centres lying beneath them.

Pressure from above downwards produces stupor.

The removal of both hemispheres in an animal has the following results :—

First, Sight and Hearing are entirely lost.

Second, Consciousness, including both Feeling and Thought, seems utterly abolished ; so that whatever bodily activity may survive, the mental life is extinct.

Third, All power of moving for an end, all forethought, purpose, or volition, is entirely extinguished. This is an inevitable consequence of the preceding fact. For without feeling and the memory of feelings and of ideas, there can be no voluntary action. The simple act of seizing food implies, besides the power of sight, the feeling of hunger and the mental association of the appearance of the food with the satisfying of the feeling.*

Fourth, The power of accomplishing many connected movements still remains. The actions of flying or walking may be sustained after the loss of the hemispheres, but in that case a stimulus from without is necessary in order to commence the action. As a matter of course, the Automatic actions, those that we have seen to go on in the decapitated or anencephalous animal may still proceed.

Fifth, The sensibility of the skin and taste and smell would appear to remain in a greatly impaired form. Such sensibility, however, cannot be of the nature of true sensation, for to have a sensation is to feel. It may consist in some mode of reflex stimulation, operated through the other centres. By operating energetically on any nerve of sense, we may excite reflex movements extending over almost all the muscles of the body.

Hence it appears that the hemispheres of the brain are indispensable to the exercise of our two highest senses, and to feeling, volition, and thought. The actions that remain are at best the actions of a somnambulist. Mind is thus pre-eminently associated with the cerebral hemispheres.

Functions of the Cerebellum.

21. The experiments made upon the cerebellum, and the inferences founded on its comparative size in different ani-

* An extraordinary apparent exception to this conclusion is furnished by an experiment on decapitated frogs, performed by Pflüger. The experiment is described as follows :—A beheaded frog, whose hind foot is touched with an acid, makes efforts with the other hind foot to wipe away the acid. If a drop is placed on the back, on one side, the animal uses the leg on that side to relieve itself of the sting ; and, farther, if by cutting the nerve that leg is rendered powerless, the other leg is stimulated to remove the acid. These actions have the character of the voluntary actions, and yet they proceed from no higher a centre than the spinal cord. We have no means of adequately explaining such a phenomenon. Possibly, in animals of a low order, the processes of will and intelligence are not so exclusively centralised in the brain, as in the higher vertebrata.

mals, have led physiologists to assign to it the function of harmonizing and co-ordinating the locomotive movements. When an action becomes complex, that is, demands the exercise of several groups of muscles in a fixed order and alternation, the due performance of the act must be provided for by some organization of the nerve centres. We have already seen that the medulla oblongata can support the two-stroke movement of the lungs; but there are still higher complexities to be provided for. The act of walking in a biped, for example, is at the very least a four-stroke movement, since there must be an impulse to and fro for either limb; and if these four strokes did not succeed in due harmony, the animal would be at a stand-still. Walking on all fours is still more complicated, demanding at least eight motions to be harmonized. The operation of chewing is another case in point; there is a complicated concurrence of movements of the jaw, the tongue, and the cheeks; and if any one of these make a false step, some accident, such as the biting of the tongue, will result. In man the actions of the hand and fingers are extremely complex. The movements connected with the maintenance of the erect posture are likewise very numerous, so much so that a long education is needed for their due performance. To as many of these actions as are primitive, or instinctive, the cerebellum is supposed to be an indispensable support, and so, doubtless, it must be to the acquired actions based on them. The following quotation from Messrs. Todd and Bowman will exhibit the experimental proofs of this function.

'Flourens removed the cerebellum from pigeons by successive slices. During the removal of the superficial layers there appeared only a slight feebleness and want of harmony in the movements, without any expression of pain. On reaching the middle layers, an almost universal agitation was manifested, without any sign of convulsion; the animal performed rapid and ill-regulated movements; it could hear and see. After the removal of the deepest layers, the animal lost completely the power of standing, walking, leaping, or flying.

The power had been injured by the previous mutilations, but now it was completely gone. When placed upon his back, he was unable to rise. He did not, however, remain quiet and motionless, as pigeons deprived of the cerebral hemispheres do; but evinced an incessant restlessness, and an inability to accomplish any regular or definite movement. He could see the instrument raised to threaten him with a blow, and would make a thousand contortions to avoid it, but did not escape. Volition and sensation remained—the power of executing movements remained; but that of co-ordinating these movements into regular and combined actions was lost.

'Animals deprived of the cerebellum are in a condition very similar to that of a drunken man, so far as relates to their power of locomotion. They are unable to produce that combination of action in different sets of muscles which is necessary to enable them to assume or maintain any attitudes. They cannot stand still for a moment, and in attempting to walk, their gait is unsteady, they totter from side to side, and their progress is interrupted by frequent falls. The fruitless attempts which they make to stand or walk are sufficient proof that a certain degree of intelligence remains, and that voluntary power continues to be enjoyed.' (T. and B., 359.)

When the cerebellum is cut away at the top, the animal moves backward. When one side is cut away, the animal rolls over to the other side; the eye of the sound side is turned outwards and downwards, the other eye inwards and upwards. Sometimes a vertiginous action ensues, as if the body were revolved on a spit.

The inference drawn from these experiments—that the cerebellum is the exclusive seat of combined movements—is denied by Dr. Brown Séquard. He says—'I have ascertained that it is by the irritation they produce on the various parts of the base of the brain that the diseases of the cerebellum, or its extirpation in animals, cause the disorder of movements which has been considered as depending upon the absence of a guiding power. In fact, the least irritation of several parts of the brain with only the point of a needle, may generate very nearly the same disorder of movement that follows the extirpation of the cerebellum. I have thus been led to conclude that, after this extirpation, or after the destruction by disease of a large or small part of this nervous centre, it is not its *absence*, but some irritative influence upon the *parts of the encephalon that remain unaltered* which causes the irregularity of movements, (Lectures, p. 79).

Still, we must admit that when the cerebellum is destroyed its functions will disappear also; and these must be some part of the functions that are lost after the deprivation of the organ. Any powers remaining cannot be dependent upon it for their basis. It is found, for example, that the loss of the cerebellum does not interrupt the conveyance of sensation and voluntary motion, between the brain and the extremities of the body.

The phrenologists have attributed to the cerebellum the sexual function, with the amatory feelings corresponding thereto; but physiologists are decidedly opposed to this view.

The white matter of the brain, which performs those incessant and innumerable acts of communication between the central masses, is thus not less important than the grey matter where force originates. Accordingly, we find that in the higher animals, the white substance becomes developed in proportion to the energy of the mental functions. As we descend the scale, the white matter dwindles in a most notable way; in birds, the grand junction of the brain, the pons Varolii, disappears as a distinct mass; and the same course of diminution is seen to proceed as we descend still farther to reptiles and fishes.

Of the Nerve Force, and the course of Power in the Brain.

22. The structure of the nervous substance, and the experiments made upon the nerves and nerve centres, establish beyond doubt certain peculiarities as belonging to the force that is exercised by the brain. This force is of a *current* nature; that is to say, a power generated at one part of the structure is conveyed along an intervening substance, and dis-

charged at some other part. The different forms of Electricity and Magnetism have made us familiar with this sort of action. In a voltaic cell, an energy is generated and transmitted along a wire with inconceivable rapidity to any place where the conductor reaches. The telegraph wire, as already said, bears a strong resemblance to a nerve passing from the brain to any part of the body; and the grey substance of the nerve centres, which are highly supplied with blood, is paralleled by the voltaic battery where the electric power is generated by the corroding power of an acid.

This portable, or current, character of the nerve force is what enables movements distant from one another in the body, to be associated together under a common stimulus. An impression of sound, a musical note, for example, is carried to the brain; the result is a responsive action and excitement extending to the voice, mouth, eyes, head, &c. This multiplex and various manifestation implies a system of connexion among the centres of action, whereby many strings can be touched from one point; a connexion due to the conducting nerves that pass and repass from centre to centre, and from the centres to the muscular apparatus over the body. Supposing the corpora quadrigemina to be a centre for the sense of vision, an impression passing to this centre propagates a movement towards many other centres,—to the convoluted hemispheres upwards, to the cerebellum behind, and to the medulla oblongata and spinal cord beneath; and through these various connexions an extensive wave of effects may be produced, ending in a complicated chain of movements all over the framework of the body. Such a system of intercommunication and transmission of power is therefore an essential part of the bodily and mental structure.

23. The experiments of Du Bois Reymond, show that there is a community of nature between the nerve force and common electricity. Electric currents are constantly maintained in the nerves and muscles, their character being changed during sensation and muscular contraction. The direction of these currents has been minutely examined by Du Bois Rey-

mond, and he lays down a number of general principles regarding them. The following are some of his conclusions :—

'The muscles and nerves, including the brain and spinal cord, are endowed during life with an electro-motive power.'

'This electro-motive power acts according to a definite law, which is the same in the nerves and in the muscles, the law of the antagonism of the longitudinal and the transverse sections. The longitudinal surface is positive, and the transverse section negative.'

'Every minute particle of the nerves and the muscles must be supposed to act according to the same law as the whole nerve or muscle.' The total currents are, in fact, the combined effect of these currents circulating round the ultimate particles.

'The current in muscles when in the act of contraction, and in nerves when conveying motion, or sensation, undergoes a sudden and great negative variation of its intensity.' 'It has not been ascertained whether, in the act of contraction, the muscular current is only diminished or wholly vanishes, or whether it changes its direction.'

Thus the proper nerve force—that is to say, the currents in the nerves during sensation and movement—is so far in unison with electricity that it neutralises and reverses genuine electrical currents proved to exist in the nerves and muscles in their condition of rest. This is the utmost that can be said in the present state of our knowledge. Even granting that the force conveyed along the nerves during the mental processes were identical with voltaic electricity, the character of the nerve substance would create some points of contrast, between the phenomena of vital action and a common voltaic battery. The conducting power of nerve fibre is attended with nervous waste, and the substance has to be constantly renewed from the blood which is largely supplied to the nerves, although not so largely as to the vesicles.

If now we compare this liability to waste and exhaustion with the undying endurance of an electric wire, we shall be struck with a very great contrast. The wire is doubtless a more compact, resisting, and sluggish mass ; the conduction requires a certain energy of electric action to set it going, and in the course of a great distance becomes faint and dies away. The nerve, on the other hand, is stimulated by a slighter influence, and propagates that influence, with increase by the consumption of its own material. The wire must be acted on at both ends, by the closure of the circuit, before acting as a conductor in any degree; the nerve takes fire from a slight stimulus like a train of gunpowder, and is wasted by the current that it propagates. If this view be correct, the influence conveyed is much more beholden to the conducting fibres, than electricity is to the copper wire. The fibres are made to sustain or increase the force at the cost of their own substance.

The nerve force is propagated more slowly than an electric current through a wire. The rate has been estimated at about 200 feet a second as an average. (It is to be remarked that a nerve is not a simple conductor, but is supposed to consist of a countless number of molecules, each of which has playing round it an electrical current, or currents, which are an obstacle to the simple or direct propagation.) There is always a certain delay in passing through the nerve centres; a reflex movement occupies from $\frac{1}{30}^{\text{th}}$ to $\frac{1}{10}^{\text{th}}$ of a second under favourable circumstances, which is more time than would be required for transmitting an influence through the same length of nerve without interruption. When the stimulus is weak, a proportionally longer time is required to produce the corresponding movement. We may hence infer that what is called nervous excitement is a quicker rate of the nervous current. The obvious facts bear out this view.

24. It is now an admitted doctrine that the nervous power is generated from the action of the nutriment supplied to the body, and is therefore of the class of forces having a common origin, and capable of being mutually converted—including mechanical momentum, heat, electricity, magnetism, and chemical decomposition. The power that animates the human frame and keeps alive the currents of the brain, has its origin in the grand primal source of reviving power, the Sun; his influence exerted on vegetation builds up the structures whose

destruction and decay within the animal system give forth all the energy concerned in maintaining the animal processes. What is called vitality is not a peculiar force, but a collocation of the forces of inorganic matter in such a way as to keep up a living structure. If our means of observation and measurement were perfect, we might render an account of all the nutriment consumed in any animal or human being; we might calculate the entire amount of energy evolved in the changes that constitute this consumption, and allow one portion for animal heat, another for the processes of secretion, a third for the action of the heart, lungs, and intestines, a fourth for the muscular exertion made within the period, a fifth for the activity of the brain, and so on till we had a strict balancing of receipt and expenditure. The nerve force that is derived from the waste of a given amount of food, is capable of being transmuted into any other form of animal life. Poured into the muscles during violent conscious effort, it increases their activity; passing to the alimentary canal, it aids in the force of digestion; at other points it is converted into sensible heat; while the same power is found capable of yielding true electrical currents. The evidence that establishes the common basis of mechanical and chemical force, heat, and electricity, namely, their mutual convertibility and common origin, establishes the nerve force as a member of the same group.

25. The current character of the nerve force, leads to a considerable departure from the ancient mode of viewing the position of the brain as the organ of mind. We have seen that the cerebrum is a mixed mass of grey and white matter,—the matter of centres and the matter of conduction. Both are required in any act of the brain known to us. The smallest cerebral operation includes the transmission of an influence from one centre to another centre, from a centre to an extremity, or the reverse. Hence we cannot separate the centres from their communicating branches; and if so, we cannot separate the centres from the other organs of the body that originate or receive the nerve stimulation. The organ of

mind is not the brain by itself: it is the brain, nerves, muscles, organs of sense and viscera. When the brain is in action there is some transmission of nerve power, and the organ that receives, or that originated, the power, is an essential part of the circle of mechanism.

The notion that the brain is a *sensorium*, or inner chamber, where impressions are accumulated, like pictures put away in a store, requires to be modified and corrected. The brain is highly retentive of the impressions made upon it; they are embodied in its structure, and are a part of its growth. They may be reproduced on after occasions, and then what we find is a series of currents and counter currents, much the same as what existed when the impression was first made. When the mind is in the exercise of its functions, the physical accompaniment is the passing and re-passing of innumerable streams of nervous influence. Whether under a sensation of something actual, or under an emotion or an idea, or a train of ideas, the general operation is still the same. It seems as if we might say, no currents, no mind. The transmission of influence along the nerve fibres from place to place, seems the very essence of cerebral action. This transmission, moreover, must not be confined within the limits of the brain: not only could no movements be kept up and no sensation received by the brain alone, but it is uncertain how far even thought, reminiscence, or the emotions of the past and absent, could be sustained without the more distant communications between the brain and the rest of the body—the organs of sense and of movement. It is true that between the separate convolutions of the brain, between one hemisphere and another, between the convoluted hemispheres and the corpora striata, thalami optici, corpora quadrigemina, cerebellum, medulla oblongata, and spinal cord, influence might be imagined to pass and repass without flowing into the active extremities or to the five senses, and might thus constitute an isolated cerebral life; but it is in the highest degree improbable that such isolation does or can exist.

MOVEMENT, SENSE, AND INSTINCT.

WE now commence the subject of Mind proper, or the enumeration and explanation of the States and Varieties of Feeling, the Modes of Action, and the Powers of Intelligence, comprised in the mental nature of man.

In the First Book, which is to comprehend the MOVEMENTS, SENSATIONS, APPETITES, and INSTINCTS, I propose to deal with what may be termed the inferior region of mind, the inferiority being marked by the absence, in a great degree, of Intellect and cultivation. This is the region wherein man may be most extensively compared with the brute creation, whose intelligence and education are comparatively small. When the powers of a superior intellect, and the example and acquirements of former generations, are superadded to the primitive Sensations and Instincts, there results a higher class of combinations, more difficult to analyse and describe, and belonging therefore more properly to a later stage of the exposition.

It will, however, be remarked as a novelty in the plan thus announced, that the Appetites and Instincts have been included in the same department as the Sensations. In the works of former writers on Mental Science, as, for example, Reid, Stewart, Brown, and Mill, those portions of our nature have been included among the general group of Active Powers, including Desire, Habit, and the Will. My reasons for departing from the example of these eminent writers are the following. In the first place, the Appetites and Instincts are scarcely at all connected with the higher operations of intelligence, and therefore they do not require to be preceded by the exposition of the Intellect. Everything necessary to be said respecting them may be given as soon as the Sensations are discussed. In the second place, I hope to make it appear, that the illustration of the Intellectual processes will gain by the circumstance, that Appetite and Instinct have been previously gone into. Thirdly, the connexion of Appetite with Sensation is so close, that the one will be found to tread on the heels of the other. Fourthly, as regards Instinct, I conceive it to be proper to render an account of all that is Instinctive in our nature—all our untaught activities—before entering upon the process of acquisition as treated of under the Intellect. In addition to these reasons stated in advance, I trust to the impression produced by the effect of the arrangement itself, for the complete justification of my departure from the plan of my predecessors.

The division of the present Book will be into four chapters.

The subject of Chapter first is Action and Movement considered as spontaneous, together with the Feelings and Impressions resulting from muscular activity.

Chapter second treats of the Senses and Sensations.

Chapter third treats of the Appetites.

Chapter fourth includes the Instincts, or the untaught movements, and also the primitive rudiments of Emotion and of Volition. These last subjects are brought on at that stage in order to complete the plan of the present Book, which professes to exhaust all the primitive germs, whether of Action or Feeling, belonging to our nature, before proceeding to the consideration of intelligence and acquisition. In the complete system of the mind the Intellect is thus placed midway between the instinctive and the cultivated emotions and activities, being itself the instrument for converting the one class into the other.

CHAPTER I.

OF SPONTANEOUS ACTIVITY AND THE FEELINGS OF MOVEMENT.

1. THE feelings connected with the movements of the body, or the action of the muscles, have come to be recognised as a distinct class, differing materially from the sensations of the five senses. They have been regarded by some metaphysicians as proceeding from a Sense apart, a sixth, or Muscular Sense, and have accordingly been enrolled under the general head of sensations. That they are to be dealt with as a class by themselves, as much so as sounds or sights, the feelings of affection, or the emotion of the ludicrous, is now pretty well admitted on all hands.

With regard, however, to the position of this class of feelings in the plan or arrangement of our subject, there is still room for differences of opinion. In my judgment they ought not to be classed with the Sensations of the five Senses, and I believe further that the consideration of them should precede the exposition of the Senses. The grounds of this belief are such as the following:—namely, that movement precedes sensation, and is at the outset independent of any stimulus from without; and that action is a more intimate and inseparable property of our constitution than any of our sensations, and in fact enters as a component part into every one of the senses, giving them the character of compounds while itself is a simple and elementary property. These assertions require to be proved in detail, but before doing so, it is advisable to notice briefly the mechanism or anatomy of movement in the animal frame.

OF THE MUSCULAR SYSTEM.

2. '*Muscular Tissue.*—The muscular tissue is that by means of which the active movements of the body are produced. It consists of fine fibres, which are for the most part collected into distinct organs, called muscles, and in this form it is familiarly known as the flesh of animals; these fibres are also disposed round the sides of cavities and between the coats of hollow viscera, forming strata of greater or less thickness. The muscular fibres are endowed with *contractility*—a remarkable and characteristic property, by virtue of which they shrink or contract more or less rapidly under the influence of certain causes which are capable of exciting or calling into play the property in question, and which are therefore named *stimuli.* A large class of muscles, comprehending those of locomotion, respiration, expression, and some others, are excited by the stimulus of the will, or volition, acting on them through the nerves; these are therefore named 'voluntary muscles,' although some of them habitually, and all occasionally, act also in obedience to other stimuli. There are other muscles or muscular fibres which are entirely withdrawn from the control of the will, such as those of the heart and intestinal canal, and these are accordingly named 'involuntary.' These two classes of muscles differ not only in the mode in which they are excited to act, but also to a certain extent in their anatomical characters.'—SHARPEY; QUAIN'S *Anatomy*, p. cxlii.

Structure of Voluntary Muscles.—'The voluntary muscular fibres are for the most part gathered together into distinct masses, or muscles of various sizes and shapes, but most generally of an oblong form, and furnished with tendons at either extremity, by which they are fixed to the bones. The two attached extremities of a muscle are named, in anatomical descriptions, its origin and insertion,—the former term being usually applied to the attachment which is considered to be most fixed, although the rule cannot always be applied strictly. The fleshy part is named the belly.

'The muscular fibres are collected into packets or bundles of greater or less thickness, named fasciculi, or lacerti, and the fibres themselves consist of much finer threads visible by the aid of the microscope, which are termed muscular filaments, or fibrillæ.

'The fibres, although they differ somewhat in size individually, have the same average diameter in all the voluntary muscles, namely, about $\frac{1}{400}$ of an inch; and this holds good whether the muscles be coarse or fine in their obvious texture. According to Mr Bowman their average size is somewhat greater in the male than in the female, being in the former $\frac{1}{352}$, and in the latter $\frac{1}{454}$, or more than a fourth smaller.'—*Ib.*

'As to the structure of fibres, it has been ascertained that each is made up of a larger number of extremely fine filaments or fibrils, inclosed in a tubular sheath.' 'It would seem that the elementary particles of which the fibril is made up, are little masses of pellucid substance presenting a retangular outline, and appearing dark in the centre.' 'The length of the elementary particles is estimated by Mr. Bowman at $\frac{1}{9400}$ of an inch. He finds that their size is remarkably uniform in mammalia, birds, reptiles, fishes, and insects.'—*Ib.*

Nerves of Voluntary Muscles.—' The nerves of a voluntary muscle are of considerable size. Their branches pass between the fasciculi, and repeatedly unite with each other in form of a plexus, which is for the most part confined to a small part of the muscle, or muscular division in which it lies. From one or more of such *primary* plexuses nervous twigs proceed and end by finer or *terminal* plexuses, formed by slender bundles consisting of two or three primitive tubules each, some of them separating into single tubules.—QUAIN, clii.

'By means of the microscope these fine nervous bundles and single tubules may be observed to pass between the muscular fibres, and after a longer or shorter course, to return to the plexus. They cross the direction of the muscular fibres directly or obliquely, forming wide arches; and on their return they either rejoin the larger nervous bundles from which they set out, or enter into other divisions of the plexus. The nervous filaments, therefore, do not come to an end in the muscle, but form loops or strings among its fibres.'—*Ib.* clii. *

I refrain from transcribing the description given of the involuntary muscles,—those of the heart, intestines, bronchial

* The active connection between the nerves and the muscles would seem to consist in an electrical current passing from the one to the other. The numerous experiments of Du Bois Reymond and others in this subject, scarcely permit any other conclusion.

tubes, iris, middle coat of the arteries, &c.—as being less important for the object of the present work. It will, however, be interesting to hear what the same authority has said on the Sensibility of muscle, and also on the Contractility, or the source of its power as a mechanical prime mover.

3. *Sensibility.*—' This property is manifested by the pain which is felt when a muscle is cut or lacerated, or otherwise violently injured, or when it is seized with spasm. Here, as in other instances, the sensibility, properly speaking, belongs to the nerves which are distributed through the tissue, and accordingly, when the nerves going to a muscle are cut, it forthwith becomes insensible. It is by means of this property, which is sometimes called the 'muscular sense,' that we become conscious of the existing state of the muscles which are subject to the will, or rather of the condition of the limbs and other parts which are moved through means of the voluntary muscles, and we are thereby guided in directing our voluntary movements towards the end in view. Accordingly, when the muscular sense is lost, while the power of motion remains,—a case which though rare, sometimes occurs,—the person cannot direct the movements of the affected limbs without the guidance of the eye.—p. clix.

On this passage I would remark that the two sensibilities described differ very much in their character. The sensibility to injuries is a fact distinct from those feelings of the state of voluntary muscles that serve to guide the movements in working for ends. The one is the passive, and the other the active, sensibility of muscle.

With regard to the other property of muscle, it is remarked as follows :—

4. *Irritability or Contractility.*—' In order to cause contraction, the muscle must be excited by a stimulus. The stimulus may be applied immediately to the muscular tissue, as when the fibres are irritated by a sharp point ; or it may be applied to the nerve or nerves which belong to the muscle ; in the former case the stimulus is said to be "immediate," in the latter "remote." The nerve does not contract, but it has the property, when stimulated, of exciting contractions in the muscular fibres to which it is distributed, and this property, named the "vis nervosa" (true nervous force), is dis-

tinguished from contractility, which is confined to the muscle. Again, a stimulus may be either directly applied to the nerve of the muscle, as when that nerve is itself mechanically irritated or galvanized; or it may be first made to act on certain other nerves, by which its influence is, so to speak, conducted in the first instance to the brain or spinal cord (or perhaps even to some subordinate nervous centre) and thence transferred or reflected to the muscular nerve.

'The stimuli to which muscles are obedient are of various kinds; those best ascertained are the following, viz.:—1. Mechanical irritation of almost any sort, under which head is to be included sudden extension of the muscular fibres. 2. Chemical stimuli, as by the application of salt or acrid substances. 3. Electrical; usually by means of a galvanic current made to pass through the muscular fibres, or along the nerve. 4. Sudden heat or cold. These four may be classed together as *physical stimuli*. Next, *mental stimuli*, viz.—1. The operation of the will, or volition. 2. Emotions, and some other involuntary states of the mind. Lastly, there still remain exciting causes of muscular motions in the economy which, although they may probably turn out to be physical, are as yet of doubtful nature, and these, until better known, may perhaps without impropriety be called organic stimuli; to this head may be also referred, at least provisionally, some of the stimuli which excite convulsions and other involuntary motions which occur in disease.'—p. clxxvii.

Of the stimuli thus enumerated the most interesting to us are the mental stimuli. These are described as of two kinds; the Emotions, or the influence of the Feelings, and the Will. A third kind is the spontaneous force to be presently discussed. There is one other property of muscle, which has been alluded to in our previous chapter, but from its importance in the discussion that is to follow, I quote a paragraph referring to it. The title is—

5. *Tonicity or Tonic Contraction*.—'Although in muscles generally contraction is succeeded by complete relaxation, there are various muscles which, after apparently ceasing to contract, remain in a state of tension, and have still a certain tendency to approximate their points of attachment, although this tendency is counter balanced by antagonistic muscles, which are in the same condition, and the limb or other moveable part is thus maintained at rest. This

condition of muscle is named "tonicity," or the "tonic state." It is no doubt a species of contraction, as well as the more conspicuous and powerful action with which it alternates; but it is employed merely to maintain equilibrium, not to cause motion, and it is not temporary but enduring—continuing during sleep when volition is in abeyance, and occasioning no fatigue. It appears to be excited through the medium of the nerves, though independently of the will, for when the nerves are cut it ceases, and then the muscles nearly become flaccid: the stimulus which acts on the nerves is not known.'—p. clxxxii.

We have already remarked, in speaking of the functions of the spinal cord, considered as a centre, that this tonicity of the muscles must be looked on as one of those functions; for the moment the spinal cord is destroyed the limbs of an animal become entirely flaccid. We also remarked, that this is an instance to prove that a muscular stimulus may originate in a centre and keep flowing out from that centre, without reference to any impressions derived from without, although the existence of such impressions, or the presence of emotion of any kind, determines a special flow of stimulus from the different centres, or grey deposits of the brain and spinal cord. The use to be made of this observation will presently appear.

PROOFS OF SPONTANEOUS ACTIVITY.

6. We have now to consider the evidence that there is for the existence of a class of movements and actions, anterior to, and independent of, the sensations of the senses. This question, brought on here to settle a point of precedence or arrangement, has a far wider import, and will re-appear on various occasions in the course of the subsequent exposition.

The proofs principally relied on are the following:—

(1.) The already mentioned fact of the tonicity of muscles. This fact I regard as proving the existence of a central stimulus in the nervous system, or that the centres possess an initiative in the phenomenon of muscular movement. It is true that the tonicity does not amount to actual movement, but the tension implied in it is only a lower degree of the same thing: and what one centre does in a low degree another may do in a higher; the peculiar mode of operation is established as a fact of the nervous mechanism.

(2.) The permanent closure of certain of the muscles—those named sphincters—is an effect of the same nature as the tonicity, but displaying a more energetic stimulus still—a stimulus that we can refer only to the spontaneous influence of some one of the centres. No impression from without can be quoted as originating this contraction. Neither could the closure be ascribed to the muscle's own contractility, which, as before remarked, may be allowed to count as something, seeing that the destruction, or paralysis, of certain of the centres leads to the total relaxation of those muscles.

(3.) It is not altogether irrelevant, to cite the activity maintained by *involuntary* muscles, as showing the existence of a mode of power originating with the nerve centres. Nervous influence is required for maintaining the breathing action, the circulation of the blood, the movement of the food along the alimentary canal, &c.; but this nervous action must evidently flow from the eentres of its own accord. Even granting that when once commenced, the impression arising from one movement is sufficient to stimulate the one that succeeds, which may be the case to some extent, as when the completed movement of expiration of the lungs initiates the succeeding inspiration, the difficulty would still present itself, How did the action commence at first? By what influence do we draw our first breath,* or set on the first stroke of the heart? If these activities cannot be kept up without the foreign assistance of nerve centres, they could not be commenced without such assistance, and so the nervous influence must precede, since we cannot suppose that a collapsed organ can originate the central stimulus that first sets it agoing.†

* The power that commences respiration in the new-born infant is still undecided. I do not wish to foreclose this question, or to deny that external stimulants may come into play to produce the effect.

† Some physiologists would ascribe the tonicity, not to the exclusive influence of the centres, but to the existence of a constant stimulation pro-

Thus the notion of an initiative existing in the nerve centres is borne out not only by the tonicity, but by the more energetic action of the sphincters, and by the analogy of the involuntary muscles. Seeing that the spinal cord and medulla oblongata are found capable of originating muscular contractions, we are entitled to suppose that the far larger masses that make up the brain, may be the sources of a much more abundant and conspicuous activity than these examples afford. If the encephalic or mental centres are the source of movements by their own energy, without the aid of sensations and impressions from without, the phenomenon is likely to show itself in them on a much larger scale. The proofs that follow are intended to put in evidence the existence of such movements.

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ceeding from the extremities by the in-going nerves. They allege in support of this view, that when all the sensory roots of the spine are cut, the tonicity disappears. This, however, would not affect the general doctrine in question. Granting that the muscular stimulus is in one sense reflex, and arises from a perennial irritation of the in-going fibres, this constant irritation is not what we usually understand by stimulation from without. It is a current arising out of some constant condition of the sensitive tissues, and not out of those visible and remitted applications to the parts that are described as stimulants. A constant stimulus is in our estimation no stimulus at all. On studying the nervous structure, as made up of conducting nerves and aggregates of cells or vesicles making the centres, we cannot help ascribing to the vesicles a specific function, different from that of the conducting fibres, namely, the function of originating a current of energy which proceeds either at once to muscles, as motor stimulation, or to other centres, and through them to the muscles at last. Now, it is reasonable to suppose that those vesicles have a character of their own apart from the nerves. In other words, a nerve centre may be so constituted as to respond weakly or strongly to an in-going stimulus, so that the return influence is not a mere echo of the other. A reflex act would thus have its energy determined partly by the energy of the stimulus, and partly by the specific force of the centres. If this be the case, everthing required by the doctrine of spontaneous energy is implied. That energy is not the pure creation of an outward stimulus, it is a central influence varying with the degree of the central energy. And if it be that the force never flows out without *some* stimulus, if the form of completing a circle must always be complied with, yet when this stimulus can be found in the internal and perennial processes of the organs, it is the same to us as if no stimulus were necessary. I should still maintain the doctrine of spontaneity for all the purposes I have in view, although the centres did not flow out except at the instance of an irritation depending on no outward agency.

(4.) In wakening from sleep, movement precedes sensation, If light were essential to the movements concerned in vision. it would be impossible to open the eyes. The act of wakening from sleep can hardly be considered in any other view, than as the reviving of the activity by a rush of nervous power to the muscles, FOLLOWED by the exposure of the senses to the influences of the outer world. I know of no circumstance that would go to show that sensation is the antecedent fact, in the case when the individual awakes of his own accord. The first symptom of awakening that presents itself is a general commotion of the frame, a number of spontaneous movements —the stretching of the limbs, the opening of the eyes, the expansion of the features—to all which succeeds the revival of the sensibility to outward things. Mysterious as the nature of sleep is in the present state of our knowledge, we are not precluded from remarking so notable a circumstance, as the priority of action to sensibility, at the moment of wakening.*

But if this be a fact, we seem to prove, beyond a doubt, that the renewed action must originate with the nerve centres themselves. The first gestures must be stimulated from within, by a power lodged in the grey masses of the brain; afterwards they are linked with the gestures and movements suggested by sense and revived by intelligence and will. The higher degree of permanent tension in the waking muscles, must be owing in part to the increased central force of the waking states, and in part to the stimulus of sensation. But in all cases, the share due to the centres must be considerable, although rendered difficult to estimate when mixed up with sensational stimulus. Thus the force that keeps the eye open throughout the day, must in some measure be due to the

* This is maintained by Aristotle, (Physica VIII. 2.) He says that these awakening movements come, not from sense, but from an internal source. Some writers have taken the opposite view, but they have not, so far as I am aware, adduced any decided facts in support of that view. If we cannot establish an absolute priority of movement in the act of awakening, we may, at least, maintain that movement concurs with, and does not follow, the re-animation of the senses.

spontaneous energy that opened it at the waking moment, for that force does not necessarily cease when the other force, the stimulus of light, commences.

We are at liberty to suppose that the nourished condition of the nerve centres, consequent on the night's repose, is the cause of that burst of spontaneous exertion that marks the moment of awakening. The antecedent of the activity in this case is, therefore, more physical than mental; and this must be the case with spontaneous energy in general. When linked with sensation and other mental conditions, the character of the activity is modified so as to render the spontaneity much less discernible.

(5.) The next proof is derived from the early movements of infancy. These I look upon as in great part due to the spontaneous action of the centres. The mobility displayed in the first stage of infant existence is known to be very great; and it continues to be shown in an exuberant degree all through childhood and early youth. This mobility can be attributed only to one of three causes. It may arise from the stimulus of sensation, that is, from the sights, sounds, contacts, temperature, &c., of outward things; in which case we should have a reflected or stimulated activity. It may, in the second place, be owing to feelings generated within the body, or states of consciousness growing out of the brain and the bodily processes generally, as when internal pains give rise to paroxysms, or high health to the lively movements of mere animal spirits. The effect may, lastly, be due to the spontaneous discharge of central vigour over all the active organs of the body,—limbs, trunk, features, voice, &c.

The two first-named influences, external sensation and inward emotion, are undoubted causes of active gesticulation and movement. But the question is, Do they explain the whole activity of early infancy and childhood? I think not, and on evidence such as the following. We can easily observe when any one is under the influence of vivid sensation; we can tell whether a child is affected by sights or sounds, or tastes, by seeing whether the attention is actually engaged upon such objects. And if the observation is carefully made, I believe it will be found, that although the gesticulations of infants are frequently excited by surrounding objects, there are times when such influence is very little felt, and when, nevertheless, the mobility of the frame is strongly manifested. With regard to inward feelings, or emotions, the proof is not so easy; but here, too, there is a certain character belonging to emotional movements, that serves to discriminate them when they occur. The movements, gestures, and cries of internal pain are well marked, and cannot be ascribed to the spontaneous energy of the centres; and highly pleasurable feeling is distinguished by the equally characteristic flow of smiles and ecstatic utterance. If there be times of active gesticulation and exercise that show no connexion with the sights and sounds, or other influence of the outer world, and that have no peculiar emotional character of the pleasurable or painful kind, we can ascribe them to nothing but the mere abundance and exuberance of self-acting muscular and cerebral energy, which will rise and fall with the vigour and nourishment of the general system.

The activity of young animals in general, and of animals remarkable for their active endowments (as the insect tribe), may be cited as strongly favouring the hypothesis of spontaneity. When the kitten plays with a worsted ball, we always attribute the overflowing fulness of moving energy to the creature's own inward stimulus, to which the ball merely serves for a pretext. So an active young hound, refreshed by sleep or rested by confinement, pants for being let loose, not because of anything that attracts his view or kindles up his ear, but because a rush of activity courses through his members, rendering him uneasy till the confined energy has found vent in a chase or a run. We are at no loss to distinguish this kind of activity from that awakened by sensation or emotion, and the distinction is accordingly recognised in the modes of interpreting the movements and feelings of animals. When a rider speaks of his horse as 'fresh,' he implies that the natural activity is undischarged, and pressing for vent;

the excitement caused by mixing in a chase or in a battle, is a totally different thing from the spontaneous vehemence of a full-fed and underworked animal.

It is customary in like manner to attribute much of the activity of early human life, neither to sensation nor to emotion, but to 'freshness,' or the current of undischarged activity. There are moments when high health, natural vigour, and spontaneous outpouring, are the only obvious antecedents of ebullient activity. The very necessity of bodily excercise felt by every one, and most of all by the young, is a proof of the existence of a fund of energy that comes round with the day and presses to be discharged. Doubtless, it may be said, that this necessity may proceed from a state of the muscles, and not from the centres ; that an uneasy craving rises periodically in the muscular tissue and is transmitted as a stimulus to the centres, awakening a nervous current of activity in return. Even if this were true, it would not materially alter the case we are labouring to establish, namely, a tendency in the moving system to go into action, without any antecedent sensation from without or emotion from within, or without any stimulus extraneous to the moving apparatus itself. But we do not see any ground for exclnding the agency of the centres. in the commencing stimulus of periodical active exercise. The same central energy that keeps up the muscular tonicity, must be allowed to share in the self-originating muscular activity. If so, the demand for exercise that comes round upon every actively constituted nature, is a strong confirmation of the view we are now engaged in maintaining.

Coupling together, therefore, the initial movements of infancy, the mobility of early years generally, the observations on young and active members of the brute creation, and the craving for exercise universally manifested, we have a strong body of evidence in favour of the doctrine of spontaneous action.

(6.) The mode of activity shown under states of excitement is in perfect consistency with the present doctrine. We find that excitement causes an unusual degree of activity, in fact an almost uncontrollable discharge of energy and power, as if the nervous centres were rendered incontinent and profuse by some temporary alteration in their nature. Whatever may be the way that the excited condition has been worked up—and there are very many ways—the character of it can be most accurately expressed by saying, that there is an extraordinary discharge of active force from the brain towards the bodily members. Every sensible impression made during this state, causes a more than average effect, and yet the current of energy does not wait for outward stimuli. Independently altogether of what a man sees, or hears, or thinks, he is disposed to be active to an uncommon degree ; these influences of sense and thought seem merely to direct or point the course of the current, they do not create it. A stream of power is flowing from the centres to the extremities ; the movements of the individual are vehement and hurried. Outward circumstances may control or modify them ; inward self-sustaining power alone seems to prompt them. Excitement in fact is but an exalted degree of spontaneity, making a weak man for the moment equal to a stronger, and simulating the effects of natural vigour and freshness by an exhausting effort of the nervous centres. It is one of the effects of strychnine to render the nerve centres unusually imitable, that is, disposed to give forth nervous currents on the slightest stimulus. The return movements, instead of being the counterpart of the stimulation, are out of all proportion to it.

(7.) As a farther confirmation, it may be remarked that sensibility and activity do not as a general rule rise and fall together ; on the contrary, they often stand in an inverse proportion to each other. By comparing different characters, or the different states of the same individual, we may test the truth of this observation. The strong, restless, active temperament is not always marked as the most sensitive and emotional, but is very frequently seen to be the least affected by these influences. The activity that seems to sustain itself, costing the individual almost no effort, being his delight rather than his drudgery, and very little altered by the presence or the absence of stimulus or ends, is manifestly a constitutional self-prompting force; and such activity may be seen in innumerable instances in the living world. This feature makes one of the fundamental distinctions of character, both in individuals and in races; being seen in the restless adventurer, the indefatigable traveller, the devotee of business, the incessant meddler in affairs; in the man that hates repose and despises passive enjoyments. It is the pushing energy of Philip of Macedon and William the Conqueror. On the other hand, sensitive and emotional natures, which are to be found abundantly among men, and still more abundantly among women, are not active in a corresponding degree, while the kind of activity displayed by them, is plainly seen to result more from some stimulus or object, than from an innate exuberance of action. The activity prompted by ends, by something to be gained or avoided, is easily distinguished from the other by its being closely adapted to those ends, and by its ceasing when they have been accomplished. He that labours merely on the stimulus of reward, rests when he has acquired a competency, and is never confounded with the man whose life consists in giving vent to a naturally active temperament, or a superabundance of muscular and central energy,

Although a less conclusive, only because more complicated, consideration than those advanced in the previously cited proofs, I do not hesitate to bring this last consideration under the notice of observant readers, as accurately chiming in with the main stream of the general argument on this subject. If action were strictly dependent on sensation and emotion, it would be found to be always proportional to those stimuli; but such proportion palpably and notoriously fails to hold good.

(8.) My last argument is one that can only be indicated here; the full illustration belongs to a more advanced stage of the exposition. In the proper place, I hope to be able to show that without this spontaneity of our actions, the growth of volition, or of activity guided to ends, is all but inexplicable.

Regions of Spontaneous Activity.

7. The natural tendency to act of their own accord belongs to all the muscles that are reckoned voluntary, and originates an extensive variety of movements. The muscles for the most part act in groups, being associated together by the organization of the nervous centres, for the performance of actions requiring the concurrence of several of them. It will be convenient to refer at the present stage to the principal groupings thus formed, in order to pass in review the different kinds of actions, that may arise independently of outward or foreign stimulation.

The Locomotive Apparatus is perhaps the most conspicuous of the voluntary groups. This involves, (taking vertebrate animals in general), the limbs, or the anterior and posterior extremities with their numerous muscles, and the trunk of the body, which in all animals chimes in more or less with the movements of the extremities. In the outbursts of spontaneous action, locomotive effort, (walking, running, flying, swimming, &c.) is one of the foremost tendencies; having the advantage of occupying a large portion of the muscular system, and thus giving vent to a copious stream of accumulated power. No observant person can have missed noticing hundreds of instances, where locomotion resulted from purely spontaneous effort. In the human subject, the locomotive members are long in being adapted to their proper use, and in the meantime they expend their activity in the dancing gestures and kicking movements, manifested by the infant in the arms of the nurse.

The locomotive action agitates the whole length of the spine up to the articulations of the neck and head. The members concerned, however, have many movements besides, especially in man, and these are found to arise no less readily. Thus the movements of the arms are extremely various, and all of them may burst out in the spontaneous way. The grasp of the hand is the result of an extensive muscular endowment, and at an early stage manifests itself in the round of the innate and chance movements.

The erections and bendings of the body are outlets for spontaneous activity, more especially erection, which implies the greater effort. When superfluous power cannot run into the more abundant opening of locomotive movement, it expends itself in stretching and erecting the body and limbs to the extreme point of tension. This is accompanied by greater vigour of inspiration of the breath, and consequent increase of expiration. The erection extends to the carriage of the head and the distension of the eyes, mouth, and features.

The vocal organs are a distinct and notable group of the active members. The utterance of the voice is unequivocally owing on many occasions to mere profusion of central energy, although more liable than almost any other mode of action to be stimulated from without. In man the flow of words and song, in animals the outbursts of barking, braying, howling, are often manifestly owing to no other cause than the 'fresh' condition of the vocal organs.

Among the varied movements of the human face, including the internal movements of the tongue and jaw, we can single out two or three distinct groupings. The *eyes* have their independent centre of energy, whence results a spontaneously sustained gaze upon the outer world. When no object specially arrests the attention, the activity of the visual movements must be considered as mainly due to central power. In the blind this is necessarily the sole influence at work. In a person deprived of the sight of one eye, we find that eye still kept open, but not so wide as the other. The *mouth* is also subject to various movements which may often be the result of mere internal power, as is seen in the contortions indulged in after a period of immobility and restraint. The *jaws* find their use masticating the food, but failing this, they may put forth their force in biting things put into the mouth, as we see in children not yet arrived at the age of chewing. The *tongue* is an organ of great natural activity, being endowed with many muscles, and having a wide scope of action. In the spontaneous action of the voice, which is at first an inarticulate howl, the play of the tongue, commencing of its own accord, gives the articulate character to utterance, and lays a foundation for the acquirement of speech.

Among the special aptitudes manifested among the lower animals we find very well-marked examples of the spontaneity of action. The destructive weapons belonging to so many tribes, are frequently brought into play without any stimulus or provocation, and when no other reason can be rendered than the necessity for discharging an accumulation of inward energy. As the battery of the Torpedo becomes charged by the mere course of nutrition, and requires to be periodically relieved by being poured upon some object or other, so we may suppose that the jaws of the tiger, the fangs of the serpent, the spinning apparatus of the spider, require at intervals to have some objects to spend themselves upon. It is said that the constructiveness of the bee and the beaver incontinently manifests itself even when there is no end to be gained; a circumstance not at all singular, if we admit the spontaneous nature of many of the active endowments of men and animals.

The spontaneous activity is always observed to rise and fall with the vigour and state of nutrition of the general system, being abundant in states of high health, and deficient during sickness, hunger, and fatigue. Energetic movements, moreover, arise under the influence of drugs and stimulants acting on the nerves and nerve centres; also from fever and other ailments. Convulsions, spasms, and unnatural excitement, are diseased forms of the spontaneous discharge of the active energy of the nerve centres.*

OF THE MUSCULAR FEELINGS.

8. We are now brought to the express consideration of the first class of phenomena proper and peculiar to mind

* A critic of this work in the *National Review*, while admitting that the doctrine here contended for, serves to explain phenomena that are left unexplained on the assumption, most generally prevailing in the systems of the human mind, that our activity is called forth solely by the stimulus of our sensations—takes exception to the purely *physical* origin above assigned to

namely, States of Feeling; these we have from the outset recognised as one of the three distinct manifestations of our mental nature. To give a systematic and precise account of the states of human consciousness,—a Natural History of the Feelings,—is one of the professed objects of the science of mind. The attempt is scarcely paralleled by any mode of procedure occurring in the sciences that embrace the outer world; the only instructive analogy that I know of, is found in some of the branches of Natural History proper, as for example, Mineralogy, where a great effort of scientific classification is needed to reduce to order the vast variety of mineral substances.

I reckon it inexpedient at this early stage to enter upon a justification of the method and order of description herein adopted for the systematic delineation of the feelings. When the method has been fully exemplified, the character and sufficiency of it will be appreciated without much difficulty.*

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the spontaneous movements. It is with the writer a serious ground of complaint that these movements are made to proceed from a "psychological nothing," or apart from any antecedent mental state. The question thus raised turns upon matter of fact, and if any observations can be produced to show that mind does manifest itself anterior to the spontaneous outburst, my statement is incorrect. But so far as I have been able to judge of what really happens, consciousness either rapidly follows or accompanies the spontaneous discharge, but does not precede it. We have unequivocal instances of movements arising without consciousness, as under chloroform and in delirium; and it is not contended that mind accompanies the movements of the fœtus in the womb. A disputed point substantially identical with this is handled at length in "The Emotions and the Will." (Emotions, chap. vii., sec. 12).

* It may facilitate the comprehension of the method, if I offer a few explanatory remarks as to the scope of it. The reader is sufficiently acquainted with the threefold partition of mind into Feeling, Volition, and Intellect. If this partition be complete and exhaustive, every mental fact and phenomenon whatsoever falls under one or other of these heads; nothing mental can be stated that is not either a feeling, a volition, or a thought. It must, nevertheless, be observed, that mental states need not belong to one of these classes exclusively. A feeling may have a certain *volitional* aspect, together with its own proper characters: thus the mental state caused by intense cold, is of the nature of a feeling in the proper acceptation of the term; we recognise it as a mode of consciousness of the painful kind, but inasmuch as it stimulates us to

9. Having seen fit to commence the present Book with Movements and muscular States, we now proceed to enumerate the Feelings connected with movement and the muscles. We need to recognise three distinct classes of these namely :—

(1.) Feelings connected with the *organic condition of the muscles*; as those arising from hurts, wounds, diseases, fatigue, rest, nutriment. Most of these affections the muscles have in common with the other tissues of the body; and the most suitable opportunity for discussing them will occur under a subsequent head, entitled the Sensations of Organic Life. Our plan requires that we should here exhibit the marked antithesis, or contrast, existing between Muscular Feeling proper and Sensation proper. The one is associated with energy passing outwards, the other with stimulation passing inwards; and although the two facts mingle together in the actual stream of mental life, it is our business to exhibit them in separation.

(2.) Feelings connected with *muscular action*, including all the pleasures and pains of *exercise*. These are the states most peculiar to the muscular system.

(3.) The Feelings that indicate the *various modes of tension of the moving organs*. According as a muscle is tense or relaxed, according as much or little energy is thrown into it,

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perform actions for abating, or freeing ourselves from, the pain, there attaches to it a volitional character also. In like manner every state that can be reproduced afterwards as a recollection, or retained as an idea, has by that circumstance a certain *intellectual* character.

Now, in describing states that come properly under the general head of feeling, we are called upon to bring forward in the first instance the peculiarities, or descriptive marks, that characterize them as feelings. This done, we may carry on the delineation by adverting to their influence on action, or volition; and, lastly, we may specify anything that is distinctive in the hold that they take of the intellect. It is clear that if a Natural History of the human feelings is at all possible, we must endeavour to attain an orderly style of procedure, such as naturalists in other departments have had recourse to. If the fundamental divisions of mind have any validity in them, they ought to serve as the basis of a proper descriptive method; in fact, the description should accord with them.

and according to the quickness or slowness of the contraction, we are differently affected, and this difference of sensibility enables us to judge of the positions of our active members, and of many important relations of external things. These are the feelings of muscle that enter most directly into our intelligence; they have little of the character of mere Feeling, and a very large reference to Thought.

All through the present chapter, and through the following chapter, on sensations, we shall require to keep in view this

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The plan in its completeness, may be represented thus:—

PHYSICAL SIDE.
- Bodily Origin. (For Sensations chiefly).
- Bodily Diffusion, expression, or embodiment.

MENTAL SIDE.
- Characters as *Feeling*.
  - Quality, *i. e.* Pleasure, Pain, Indifference.
  - Degree.
    - As regards Intensity or acuteness.
    - As regards Quantity, mass, or volume.
  - Special characteristics.
- *Volitional* characters.
  - Mode of influencing the Will, or Motives to Action.
- *Intellectual* characters.
  - Susceptibility of being Discriminated.
  - Susceptibility to Comparison or Agreement.
  - Degree of Retainability, that is Ideal Persistence and Recoverability.

It is to be remarked that, as a general rule, pleasures agree in their physical expression, or embodiment, and also in their mode of operating on the will, namely, for their continuance, increase, or renewal. In like manner, pains have a common expression, and a common influence in promoting action for their removal, abatement, or avoidance. Hence the fact that a state is pleasurable or painful carries with it these two other facts as a matter of course.

Again, as regards the Intellect; Discrimination, Agreement, and Retainability are to a certain extent proportional to the *degree* of the feeling, or the strength of the impression. This being the case, the statement of the degree involves the probable nature of the properties connected with the Intellect. Hence it is unnecessary in most cases to carry the delineation through all the particulars of the table. It is only when a feeling possesses any peculiarities rendering it an exception to the general laws of coincidence now mentioned, that the full description is called for. Two or three examples of the complete detail will be given.

distinction between feelings that yield a large measure of the distinctive character of feeling, and others whose emotional character is feeble, and whose function it is to supply the materials of the intelligence. In the eye, for example, the effect of a blaze of sunshine, is of a very different nature from the sight of a watch. The one serves for the purpose of immediate enjoyment, the other is nothing in itself, and derives its value from intellectual applications and the rational guidance of our life. The contrast between music and speech expresses the same distinction among effects on the ear.

I. *Of the Feelings of Muscular Exercise.*

10. These are the feelings proper and peculiar to the muscular system. The mode of consciousness produced by movement and exercise cannot be made to spring from any other part of the system.

I do not here take into account the circumstances that stimulate or set on the movement. I desire to keep, as close as possible, to the states of mind generated by the act of muscular exertion, howsoever commenced. The stimulus may be spontaneous influence, feeling, or volition. Taking the entire situation into account, there will be great differences according to the mode of origin; but under all these differences there is one thing common, namely, the influence spread over the conscious centres when muscular contraction takes place. The nature of that consciousness we have now to define.

11. The first and simplest case of muscular exertion, is when the exertion is unaccompanied by movement, as in supporting a weight, or encountering a dead resistance. Here we have the feeling probably in the purest and least complicated form of it.

To begin with the PHYSICAL side.

The physical state of a muscle under contraction may be inferred from the details already given. The particles making up the muscular threads are approximated by an energetic attraction developed in the muscle, under the stimulus supplied by the nerves. An intense physical force is produced by a peculiar expenditure of the substance of the muscular mass; and in the production of this force the tissue is affected, as it were, with a strong internal agitation. As the nerves supplied to the muscles are principally motor nerves, by which the muscular movements are stimulated from the brain and nerve centres, our safest assumption is that the sensibility accompanying muscular movement coincides with the outgoing stream of nervous energy, and does not, as in the case of pure sensation, result from an influence passing inwards, by ingoing or sensitive nerves. It is known that filaments of this class are distributed to the muscular tissue, along with the motor filaments; and it is reasonable to suppose that by means of them the *organic* states of the muscle affect the mind. It does not follow that the characteristic feeling of exerted force should arise by an inward transmission through the sensitive filaments; on the contrary, we are bound to presume that this is the concomitant of the out-going current by which the muscles are stimulated to act. No other hypothesis is adequate to represent the total opposition of nature between states of energy put forth, and states of passive stimulation.*

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* I shall here present the views of some of the most distinguished physiologists upon this interesting question. I must premise, however, that none of them advert to the presumption arising from the great antithesis of movement and sensation, throughout the whole mental system. To them it would be a small matter, that the feelings of movement were ranked as merely another class of sensations, or impressions passing to the brain by sensitive nerves. In my view, on the contrary, the most vital distinction that it is possible for us to draw within the sphere of mind, is bereft of all physiological support by such an hypothesis. I quote first from Dr. Brown Séquard: 'J. W. Arnold has tried to show that the anterior roots of nerves contain the nerve fibres which convey to the sensorium the impressions that give the knowledge of the state of muscles,' as to degree of contraction or amount of movement. 'The chief fact on which he grounds his opinion is, that after section of the posterior roots of the posterior extremities of a frog, it can make use of its hind legs almost as well as if nothing had been done to the

But the physical accompaniments of muscular exertion must be traced beyond the muscles themselves. We know that bodily exercise indirectly affects all the organs of the body. The circulation of the blood is quickened generally,

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posterior roots.' It would appear, then, that not only the power of movement, but also the sense that guides the movements, is unconnected with the sensory nerves. 'This experiment is certainly of some value, and we must acknowledge that it is difficult to explain it otherwise than Arnold has done. Moreover we have found that, after the section of *all* the posterior roots of the spinal nerves in frogs, the voluntary movements seem to be very nearly as perfect as if no operation had been performed, and that if the skin of the head is pinched on one side, the posterior limb on the same side tries to repel the cause of the pain, as well as if no injury had been made. I have also ascertained that in frogs rendered blind these experiments give the same result.'

But Arnold's hypothesis is not the only alternative. The supposition that the mind discriminates the degree of energy of the motor current, or the force poured out from the brain in voluntary movement, is at last an equally admissible view. It would seem an unnecessary complication to have sensory nerves mixed up with the pure motor fibres; it would be to deny that the anterior roots are pure motor nerves. Dr. Brown Séquard proceeds to remark:—'But although I agree so far with Arnold, I do not admit with him that it is only through the anterior roots that impressions are conveyed by the muscles to the brain. When a galvanic current is applied to the muscles of the limb of a frog, on which the posterior roots of the nerves of this limb have been divided, no trace of pain is produced, and all the other causes of pain are also unable to cause it when applied either to the skin or the muscles.'—(Lectures, p. 9.) This is in perfect accordance with the view that would assign the feelings of resistance and movements to the outgoing current by the motor nerves, and the sensibility to cramp and other pains, to the ingoing current by the sensory nerves.

E. H. Weber remarks:—'The discriminative sensibility of muscle seems, in many cases, owing to the presence, in muscle, of branches of the nerves of sensation going to the extremities, as we see in the distribution of twigs of the trigeminal nerves to the various muscles of the eye. This supply of sensitive nerves to the eye may be contrasted with the case of the diaphragm, a muscle under the influence of the will, yet less discriminative than the muscles of the eye, and scantily supplied with nerves of sensation. It would seem, nevertheless, that all does not depend in that; for, in many cases of complete and genuine anœsthesia (that is, loss of sensibility to pain), the power of voluntary motion in the senseless parts is still preserved.' This is a still more decided fact, inasmuch as the existence of insensibility to pain shews, that all the sensitive fibres are paralyzed, and yet the power of muscular guidance remains. This is consistent only with the supposition that the mind appreciates the motor influence as it proceeds from the brain to the and is made to flow by preference to the muscular tissue, the brain being in this way often relieved from a morbid excess of blood. The lungs are stimulated to increased action. The elimination of waste matter from the skin is promoted.

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muscles, without depending on a returning sensibility through the proper sensory fibres.

I quote next from Ludwig. 'Whether the nerves that subserve the muscular sense, and those that induce the muscular motion, are the same, is at present difficult to decide. It is conceivable, and not unlikely, that all knowledge and discrimination arrived at through the exertion of the voluntary muscles, are attained directly through the act of voluntary excitation; so that the effort of the will is at once proceeded on as a means of judgment. This opinion is supported by the fact that the movements that give us mental judgments, in by far the greater number of cases, do not appear as muscular sensations;' in other words, they are not, like the organic sensations of muscle, localised by us in the muscle and looked upon as possessing the characters of a sensation. Ludwig thus appeals to our consciousness as presenting the feeling of muscular energy in a characteristic form, and distinct from the feeling of muscular pains And in this he seems to be right: for if we are to trust consciousness in the matter, we should say that in the case of a voluntary effort, the feeling is as of power going out of us, and not as of a surface of sense stimulated by an external agent, and transmitting an impression inwards to the nerve centres.

The view that *organic* muscular pains are stimulated through the *sensory* fibres is strongly maintained by Ludwig. His reasons are:—First; Sensory fibres are distributed to the muscles along with the motor nerves. Secondly, the involuntary muscles, no less than the voluntary, are the seat of acute pains. Thirdly, the stimulation of the anterior roots does not produce pain. Fourthly, pains arising from long-continued action of the muscles exist for days after the cessation of the excitement of the motor nerves. This last phenomenon is explained by the chemical destruction of the muscular tissue, which has an irritating effect upon the sensory nerves existing in the muscles.

Finally, Wundt expresses himself as follows: 'Whether the sensations, accompanying the contraction of the muscles, arise in the nerve-fibres that transmit the motor impulse from the brain to the muscles, or whether special sensory fibres exist in the muscles, cannot be decisively settled. Certain facts, however, make the first assumption more probable. If special nerve-fibres existed, they must be connected with special central cells, and thus, in all probability, the central organs for the apprehension of these sensations would be different from those which send out the motor impulse; there would be two independent nerve-systems, the one centripetal, the other centrifugal. But in the one—the medium of the sensation—nothing else could be regarded as the stimulus than the changes taking place in the muscle, the contraction, or perhaps the electrical process in nerve and muscle accompanying the con-

Animal heat is generated in greater quantity. Provided the waste of nutritive material caused by these various modes of increased action is duly supplied, the vital force of the system as a whole is raised by muscular exercise.

So much for the corporeal seat or Origin of the sensibility in question. There is still another physical aspect of this as of all other emotional states, which we shall advert to before passing to the declineation of the proper mental characters; that is to say, the Expression or embodiment of the Feeling, which is not only the means of making known the state to others, but also an essential concomitant of its own existence.

By the very nature of the case the feeling arising from great bodily exertion, is liable to be wanting in Expression, properly so called. The organs are so completely employed in the exercise itself, that they are not disposable as instruments of the expression of the feeling. The features of the face and the voice, which are by pre-eminence the organs of expression, are exerted chiefly in sympathy with the muscles engaged in the exercise. As regards outward embodiment, therefore, there is nothing peculiar to be remarked in connection with muscular effort in general. It is only when the feeling happens to be pleasurable or the reverse that any expression is shown, and that is merely the attendant of the pleasure or the pain as such.*

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traction. Now, this process is known to keep equal pace with the energy of the muscular contraction; and we must expect that the muscular sensation would constantly increase and decrease with the amount of internal or external work done by the muscle. But this is not the case, for the strength of the sensation is dependent only on the strength of the motive impulse, passing outwards from the centre, which sets on the innervation of the motive nerves.' This is proved by numerous cases of pathological disturbance of the muscular action in a limb. The patient can make a great muscular exertion, and have the corresponding sensation, *although the limb be hardly moved.* But, naturally, after long-repeated trial, this small movement becomes associated with the increased exertion.

* It enters into the plan of this work to state in all cases the known physical accompaniments of our various feelings or conscious states. This may seem to some to be introducing a foreign element into the philosophy of

12. We pass now to the MENTAL side. In reviewing the characteristics of the mental accompaniment of muscular action, viewed as *Feeling*, we advert first to its Quality.

Observation shows that this is pleasurable, indifferent, or painful, according to the condition of the system. The first outburst of muscular vigour in a healthy frame, after rest and nourishment, is highly pleasurable. The intensity of the pleasure gradually subsides into indifference; and, if the exercise is prolonged beyond a certain time, pain ensues. In ordinary manual labour there may be, at commencing in the morning and after meals, a certain amount of pleasure caused by the exercise, but it is probable that during the greater part of a workman's day, the feeling of exertion is in most cases indifferent. If we confine ourselves to the discharge of surplus energy in muscular exertion, there can be no doubt that

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the human mind. The following reasons may be given in justification or this course.

First. There are bodily movements and effects that regularly happen in company with our feelings. We smile when pleased, frown when angry, tremble when alarmed. In many instances the bodily display is so characteristic as to reveal the inward state, even to nicety. A great part of human interest centres in these outward manifestations; and to reproduce them is a leading function of the painter, sculptor, actor, and poet. They are, therefore a branch of knowledge and study for practical and for artistic purposes, and if so it cannot be irrelevant to study them scientifically. Now it is difficult to find any place where their consideration falls more naturally than in the subject of the present work. It is true that hitherto the physical embodiment of mind has been neglected by metaphysicians; indeed the neglect is almost universal. The only work devoted to it expressly is the 'Anatomy of Expression,' by Sir Charles Bell.

Secondly. I look upon the expression so-called as part and parcel of the feeling. I believe it to be a general law of the mind, that, along with the fact of inward feeling or consciousness, there is a diffusive action or excitement over the bodily members. I may at present cite, as an illustration, the effect of a blow; it being well known that in proportion as this is felt as a pain, it causes a shock and agitation over the whole body, manifested in the convulsive start, the cry, the contortion of feature, so familiar to us in our experience of men and animals. According to this view, every variety of consciousness ought to have a special form of diffusive manifestation. It is not every state, however, that carries this diffusive action far enough to be ostensible as a characteristic outward display.

this is a considerable source of pleasure in the average of human beings, and doubtless also in the animal tribes. The fact is shown in the love of exercise for its own sake, or apart from the ends of productive industry, and the preservation of health. In the case of active sports and amusements, there are additional sources of pleasurable excitement, but the delight in the mere bodily exertion would still be reckoned one ingredient in the mixture.

A part of the pleasure of exercise must be attributed to the increase of vital power generally, and the question arises, may not the whole be due to the augmented force of the circulation, respiration, &c.? It is certain that the rising to a higher condition as regards these important functions, is a source of pleasurable excitement. It is reasonable to suppose, however, that the muscular system, which is the seat of so much unquestioned sensibility, should be capable of affording pleasure under favourable conditions. And I think our consciousness attests the same fact. Part of the agreeable feeling in the exercise of the muscular organs, when the body is strong and fresh, can be localised, or referred to the muscles actually engaged. And it will be seen, as we proceed, that there are various facts connected with movement that are inexplicable, unless we suppose that the muscular tissue is of itself a seat of pleasurable, as it certainly is of painful, sensibility.

As to the degree of this pleasure, we must of course pronounce it variable according to circumstances. But taking a common case, as that of an average healthy human being, going through each day the amount of bodily exercise that the system can afford, we should have to admit that this is an appreciable constituent of happiness. Doubtless by contriving such a combination of exercises as to bring all the powerful muscles into full play, the pleasure could be increased considerably above the ordinary experience in this respect. The pleasure is not what would be called acute, or of great intensity; its degree arises from the stimulation of a large mass of tissue.

A measure of the degree of our pleasures is found, not merely in comparing one with another in consciousness, but also in observing the pains that they are respectively able to subdue. In this particular case, however, there is a tendency to subdue pain, not through the evolution of pleasure merely, but through some of the direct physical consequences of muscular movement. The derivation of blood from the brain reduces the cerebral excitement, and with that the mental excitement, and so may operate in quenching painful irritation.

The third point in the description, respects any speciality in the case, serving still further to describe or characterize the feeling in question. Now, as regards muscular exertion, there is a notable speciality, a radical difference in kind, signified by such phrases as 'the sense of power,' 'the feeling of energy put forth,' 'the experience of force or resistance.' This is an ultimate phase of the human consciousness, and the most general and fundamental of all our conscious states. By this experience we body forth to ourselves a notion of force or power, together with the great fact denominated an external world. In the sense of energy exerted, we are said to go out of self, or to constitute a something in vital contrast to all the rest of our mental experiences, a *not me* as opposed to the *me* of passive sensibility and thought.

With regard to the *Volitional* peculiarities of the pleasure of muscular exercise there is not much to be remarked. As a pleasure it will work for its own perpetuation, increase, or renewal. According to the doctrine of spontaneous activity, the sense of pleasure would not be necessary for our passing into an active state in the first instance; but would simply operate to maintain the activity, and, by help of intelligent forethought, to keep the system in a high condition of fitness for the periodical effusion of energy.

The *Intellectual* properties of the muscular feelings that is to say our discriminative sensibility in connection with them, our sense of their agreement, and their persistence and recoverability in idea, are so important as to require a separate consideration. We shall merely allude here to one small part of the case, namely, our recollection of states of muscular exercise regarded as pleasure, so as to render them an object of desire and pursuit when they are not actually present. This is a truly intellectual property of feeling. In so far as active amusements and sports, and occupations largely involving muscular exercise, are a fixed object of passionate pursuit, to that extent they abide in thought, or stand high in one of their intellectual aspects.

13. Having thus endeavoured to present a delineation of the first and simplest variety of muscular consciousness under exertion, we shall now cite a few examples of this form of the feeling.

The supporting of a weight on the back, head, or chest, or by the arms, is a common example of dead tension. The most interesting form of it is the support of the body's own weight, which yields a perpetual feeling of the muscular kind, varying with the attitudes. The feeling is least when we lie at full length in bed, and greatest in the erect posture. Sometimes the weight is oppressive to us, and gives the sensation of fatigue; in a more fresh condition of the muscles it makes one item of our pleasurable consciousness. The fatigue of standing erect for a length of time is, perhaps, one of the commonest cases of muscular exhaustion. The pleasure of standing up after a lengthened repose gives an opposite feeling. When the bodily strength is great, the laying on of a burden is a new pleasure.

This case of great muscular tension, without movement, presents itself under a variety of forms, in the routine of mechanical operations, and in many other ways. In holding on as a drag, in offering or encountering resistance of any sort, in compressing, squeezing, clenching, wrestling, the situation is exemplified.

A certain amount of movement may be permitted without essentially departing from the case of dead tension, as in dragging a vehicle, and in efforts of slow traction generally.

14. When muscular tension brings about Movements, there must be a gradually increasing contraction, and not a

mere expenditure of power at one fixed attitude. Each muscle has to pass through a course of shortening; beginning, it may be, at the extreme state of relaxation, and passing on, sometimes slowly, and at other times rapidly, to the most shortened and contracted condition. The sensibility developed during this process, is greater in degree, and even somewhat different in kind, from that now discussed. As a general rule, the feeling is more intense under movement, than under exertion without movement. The successive contraction of the muscle would seem capable of originating a more vivid stimulus than the fixed contraction. We even find, that, in different degrees of rapidity, the sensibility changes considerably, which requires us to make a division of movements into several kinds.

15. Let us first advert to what we may term, by comparison, *slow* movements. By these I understand such as a loitering, sauntering walk, an indolent style of doing things, a solemn gesture, a drawling speech, whatever is set down as leisurely, deliberate, dawdling. The emotion arising from this kind of movement is far greater than an equal effort of dead tension would produce. Indeed we may say, that this is an extremely voluminous and copious state of feeling: being both abundant and strong, although deficient in the element that we recognise as the sense of energy, or of expended force; in fact, approaching more to the class of passive feelings. We may derive the greatest amount of pleasurable sensibility, at the least cost of exertion, through the means of well-concerted slow movements. In this case, it seems not unlikely that the proper sensibility of the muscular tissue, awakened through the medium of the sensitive nerves, is roused, together with the sense of expended energy. The resemblance of the state to the feeling of muscular repose (which probably makes an element in the voluminous sensation of approaching sleep) favours this view. The sense of expended energy is small, in fact almost wanting. But we must not overlook another circumstance, accounting for a copious sensibility under a small expenditure of force. When the energies of the system

are strongly directed into the current of muscular activity, they are less available for the support of sensibility or feeling. The putting forth of energy in bodily movements, is a diversion of the forces from the seats of passive sensibility, and is a well known remedy for too great mental excitement.

The relationship of the feeling in question to muscular repose and approaching sleep, is seen in the tendency of slow movements to induce those states. They are pre-eminently soothing in their nature, and when the system has contracted a morbid restlessness, they can gradually restore it to the healthy condition. After a bustling day, tranquillity is attained by the mere sympathy of measured movements, as music and the conversation of persons of sedate elocution. There is also a close intimacy between the feelings of slow movement and certain powerful emotions, as awe, solemnity, veneration, and others, of the class of mingled tenderness and fear, entering into the religious sentiment. Accordingly, the funeral pace, the slow enunciation of devotional exercises, the drawling tones of organ music, are chosen as appropriate to the feelings that they accompany. All this still farther supports the position that the feeling under consideration is not one of active energy, but the opposite. For all those sentiments are the response of man's powerlessness and dependence, and are developed according as the sense of his own energy is low. And it must happen from the mutual exclusion of the two contrasting states, that the one operates as the corrective of the other.

16. There is every reason to believe that movements gradually increasing or gradually diminishing, are more productive of pleasurable emotion than such as are of a uniform character. Indeed a uniform movement is altogether of artificial acquirement. The natural swing of the limbs tends to get quicker and quicker up to the full stretch, and to die away again gradually. There would appear to be a special emotion connected with the acceleration or steady diminution of movement. The gradual dying away of a motion is plea-

surable and graceful in every sort of activity—in gesture, in the dance, in speech, in vision. The 'dying fall' in sound is an illustration of the same fact, although from the obscurity of the mechanism of hearing, we cannot say whether it is a muscular, or a strictly auditory effect. It can be shown that this is the peculiarity constituting the beauty of curved lines and rounded forms.

Possibly the effect may be explained on the great law of Relativity, or the necessity of change to our being mentally affected. A gradual acceleration or diminution of any agent that wakens sensibility is the surest antidote of monotony, in other words, the condition most favourable to consciousness.

17. We pass next to the consideration of *quick* movements. They differ considerably in feeling both from dead exertion and from a slow rate of action. Although there may seem to be a common muscular sensibility at the bottom, the specific nature of it is greatly altered. One accompaniment of the quickness is the increased excitement of the nerves; an increase totally distinct from the addition of energy expended to heighten an effort of dead resistance. Mere rapidity of movement has a specific influence in exciting the nerves and nerve-centres to a greater spontaneous activity; in short, it belongs to the class of nervous stimulants. The stimulation would appear to be all the greater, when the organs encounter no resistance, and so draw but little on the muscular expenditure. For inducing an unwonted degree of excitement generally, for inflaming the animal spirits, and bringing on various manifestations and exaggerated efforts, we find that quick movement is an available instrumentality. We may compare it in this respect with acute pains (not severe enough to crush the energies), and with the stimulus of irascible emotion. Rapid motions are a species of mechanical intoxication. Any one organ, however small, made to move quickly, imparts its pace to all the other moving organs. In a rapid walk, still more in a run, the mental tone is excited, the gesticulations and the speech are quickened, the features betray an unusual tension. We must ascribe this result solely

to an exalted condition of the nervous system, of the kind produced by intoxicating stimulants generally.

Examples of this class of motions and feelings are sufficiently abundant. They are expressly sought to give hilarity and excitement to human life. The chase, the dance, the vehemence of oratory and gesture, the stirring spectacle, are prized for their stimulating character as well as for their proper sensations. In the ecstatic worship of antiquity, in the rites of Bacchus and Demeter, a peculiar phrenzy overtook the worshippers, yielding an enjoyment of the most intense and violent character, and in its expression mad and furious. This state is often brought on among the Orientals of the present day, and always in a similar manner, that is, by rapid dancing and music under the infection of a multitude.

Movements, when too quick, frequently excite the brain to the state of dizziness and fainting, showing the extreme effect of the peculiarity we are describing.

Thus, then, Dead Resistance is a source of pleasure in a healthy system, a derivative of morbid excitement from the brain, and the origin of our most general and fundamental sensibility, constituting the consciousness of the object, or external, world. Slow Movements are allied to the passive pleasures, and may affect us more through the sensitive, than through the motor, nerves of the muscles. Quick Movements affect us less as movement, than as stimulating the nerves to increased action, the consequence being a higher mental tone for feeling, for volition, and for thought.

18. A remarkable feeling connected with movements, is that arising from the sudden loss of support, as when the footing, or any prop that we lean upon, suddenly gives way. The contraction of a muscle demands two fixed points of resistance at its extremities; if one of those breaks loose, the force of the contraction has nothing to spend itself upon, and a false position is incurred. The contraction suddenly freed from its resistance does not make a vehement convulsive collapse like a spring; it would appear rather that the contractive force ceases almost immediately; and the sensation result-

ing is one of a most disagreeable kind. It would seem to result rather from the jar given to the nervous system than from any influence flowing out of the muscle. The whole frame is agitated with a most revulsive shock, the cold perspiration is felt all over, and a sickening feeling seizes the brain. The breaking down of any prop that we are resting on, the snapping of a rope, or the sinking of a foundation, exemplify the most intense form of the effect. We may probably look upon the peculiar influence whose repetition induces sea-sickness, as of the same nature. The sinking of the ship has exactly the same unhinging action in a milder degree, although when continued for a length of time, this produces a far worse disturbance than any single break-down, however sudden. The precise physiological action in this situation, does not seem agreed upon; the feeling is known to be one of the most distressing that human nature is subject to, being an intense and exaggerated form of stomachic sickness, with sensations in the head more aggravated than those occurring under any ordinary emetic.*

19. We must advert next to what are improperly called *passive* movements. Under these we include the case of being driven, or carried along, by some power without us. Riding in a vehicle is the commonest instance. One of the pleasures of human life is to be driven along at a moderate speed, in an easy carriage. Now it may be supposed at first sight, that there ought to be no feeling of muscular exertion whatsoever in this case, seeing that the individual is moved by other force than his or her own: and under certain circumstances this would be strictly true. We have no feeling of our being

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* Sea-sickness is explained by some as the result of the excessive flow of blood to and from the head. When the ship makes a downward motion, the feeling of loss of support is accompanied by a rapid flow of blood to the brain, and when the ship rises as rapid a flow ensues in the opposite direction. It is asserted further that the flow either way may be diminished, if an upward motion of the body be made at the time of the ship's downward motion, and a downward motion at the time of the ships rising, and that sickness can in this way be prevented.

moved round with the earth's rotation, or through space by the movement about the sun. So in a ship we often lose all sense of being driven or carried along, and feel pretty much as if there were no forward movement at all. The sensibility arising in a carriage movement, is in part imbibed through the eye, which is regaled by the shifting scene, and partly through the irregularities of the movement, which demand a very gentle action of the muscles of the body in order to adapt it to those irregularities. By springs and cushions all violence of shock is done away, while the easy exercise caused by the commencement and stoppages of the motion, by the slight risings and fallings of the road, is somewhat of the nature of that influence already described as arising from slow and gentle movements. It must not be forgotten, however, that the stimulus of the fresh air, procured at little expense of exertion, and with the eye amused by a shifting scene, is no small part of the agreeableness, as well as wholesomeness of the situation.

In horse exercise there is a larger amount of the ingredient of activity. The rider is saved a part of the exhaustion caused in walking, and has yet exercise enough for the stimulus of the bodily functions, and for exciting muscular pleasure.

The rocking chair, introduced by the Americans, who seem specially attentive to the luxuries of muscular sensibility, is another mode of gaining pleasure from movement. Anciently, furniture was adapted for the pleasures of repose solely, but now the boy's rocking horse has its representative among the appurtenances of grown men.

On the whole, it is apparent that a large fraction of physical enjoyment flows out of the moving apparatus and muscular tissue of the body. By ingeniously varying the modes of it, this enjoyment is increased still farther. The pleasure comes incidentally to manual labour, when moderate in amount and alternated with due sustenance and repose, and is a great element of field sports and active diversions of every kind ; it is a part of the pleasures of locomotion ; and in gymnastic exercises and athletic displays contributes the principal ingredient.

II. *Of the Discriminative or Intellectual Sensibility of Muscle.*

20. Under the foregoing head, I have dwelt more exclusively on the emotional aspect of muscular exercise, or the consideration of it as pleasure or pain. But the same sensibility has to be viewed in a far more important aspect, the intellectual. The greater number of our experiences of the feelings of movement are indifferent or neutral, as respects our enjoyments; their function lies wholly within the intellectual consciousness. They enter into the sphere of knowledge and thought.

This function of our muscular sensibility arises, in the first instance, from our being conscious of the different *degrees* of it. We have not only a certain feeling when we put forth muscular power, but we have a change of feeling when we raise or lower the amount of the power. If we hold a weight of four pounds in the hand, the consciousness is changed when another pound is added. This change of feeling is Discrimination, and is the basis of our intelligence; as pleasure or pain, is nothing, but as the commencement of knowledge, it is all-important.

The modes of muscular action that affect us by their differences of degree, appear to be these. The first is the amount of exertion, or of expended force, which measures the *resistance* to be encountered. This is the fundamental experience. The second respects the *continuance* of the exertion. This applies both to dead strain and to movement. The third is a mode of movement solely; it is the *rapidity* of the muscle's contraction, which corresponds with the velocity of movement in the organ. In distinguishing the qualities of external things, and in forming permanent notions of the world, all these discriminations are brought into play.

21. First, with respect to degrees of Exertion or of Expended force. This is the sense of Resistance, and corre-

sponds to our conception of Body, and is our measure of Force, Inertia, Momentum, or the Mechanical property of matter.

Along with every kind of feeling whatsoever, we have a sense of degree or intensity. We can discriminate between a more and less vehement emotion. When experiencing the pain of fatigue, or the pleasure of healthy exercise, we recognise differences in the different stages of the feeling. To be affected *more* or *less* in different circumstances, is a consequence of being affected at all. Accordingly, as a feeling rises or falls, our difference of sensibility leads to a comparison, and the comparison gives birth to what we call the sense of difference. There is implied in it a certain amount of permanence of a past impression along with the full reality of the present; without some such endurance of impressions comparison would be impossible; we should live in the present moment and in that alone. This sentiment of difference determines our voluntary activity; that is to say, it prompts a continuance of the action that heightens a pleasure, or soothes a pain. It goes still further, and is the foundation of all those discriminative impressions of outward things entering into our intellectual comprehension of the world. Sights and sounds, and touches and tastes, have a variety corresponding in some degree to the variety of natural objects, and thereby constitute what we call our 'knowledge' of those objects.

To apply this to the case now before us. We have a certain feeling when called to exert our muscular energy in setting on movement, or in encountering resistance. We have a certain degree of consciousness for some one degree of exertion; when the exertion increases, so does the consciousness. If a porter has a load on his back of one hundred weight, he has a peculiar and distinct muscular feeling associated with it; if other thirty pounds were added, he would have a sense of the addition in the increased expenditure of force; if thirty pounds were removed, he would have a feeling of diminished expenditure. In short, there is a perfect discrimination of degrees and difference of muscular energy, which serves us as a means of discriminating the resistances that we encounter. Hence we are able to say that one body resists more than another—possesses in greater degree the quality that, according to circumstances, we call force, momentum, inertia, weight, or power. When we encounter two forces in succession, as in a wrestling match or a dead push, we estimate them according to this sensibility, the one greater, the other less, as it may happen.

22. Among the various cases where the sense of graduated resistance comes into play, we may mention first, the momentum or force of moving bodies. Where we have to check or resist something in motion, as in bringing a vehicle to rest, our sensibility to expended exertion leaves with us an impression corresponding to the momentum of the vehicle. If we were immediately after to repeat the act with another vehicle heavier or swifter than the first, we should have a sense of increased effort, which would mark our estimate of the difference of the two forces. Supposing the impressions thus made to be gifted with a certain kind of permanence, so that they could be revived at an after time, to be compared with some new case of checking a moving body, we should be able to say which of the three was greatest and which least, and we should thus have a scale of sensibilities corresponding to the three different degrees of moving force. It is no essential departure from the dead strain to set a resisting body into slow motion, as in digging the ground, rowing a boat, or dragging a vehicle. In all these instances, there is an estimate of expended force. Every carriage horse knows the difference of draught between one carriage and another, between rough and smooth ground, and between up hill and down hill. This difference the animal comes to associate with the carriage, or with the sight of the road, and in consequence manifests preferences whenever there is an opportunity ; choosing a level instead of a rising road, or the smooth side in preference to the rough.

The appreciation of *weight* comes under the same description of sensibility. This applies to burdens in general, and also to the discrimination of quantity of material through weight. We remark a difference between half an ounce and an ounce, or between five pounds and six pounds, when we try first the one weight and then the other. The generality of people can appreciate far nicer differences than these. A sensitive hand would feel the effect of a very small fraction of an ounce added to a pound.* In this respect, there would appear to be wide constitutional differences, and also differences resulting from practice, among different individuals. We are all sensitive to some extent, but there is for each person a degree of minuteness of addition or subtraction that ceases to be felt; this is the limit of sensibility, or the measure of delicacy in the individual case.

There are two modes of estimating weight, the relative and the so called absolute, which, however, means relation to a permanent standard. By relative weights we understand the comparison of two or more weights together, or by taking them in turn, they being all actually present; as when among a heap of stones we pick out what we deem the heaviest. Absolute weight implies a permanent standard, and a permanent impression of that standard. When taking up a lump of lead, and feeling the weight of it, I pronounce it to be seven pounds, I make a comparison between the sense of the lead and the impression acquired by handling the standard weight of seven pounds, or things known to be equivalent thereto. This absolute comparison, therefore, implies that enduring and recoverable sensibility to impressions of resistance above alluded to as a possible fact of the human constitution. The fact is not only possible but real, as every one knows. We can acquire a permanent sense of any one given weight or degree of resistance, so as to be able at all times to compare it with whatever weight may be presented. A receiver of posted letters acquires an engrained sensibility to half an

* Weber says, that by muscular sensibility alone, even unpractised persons can distinguish 39 ounces from 40; whereas it is only with the greatest difficulty that 29 ounces can be distinguished from 30, by the sensibility of touch without muscularity.

ounce, and can say of any letter put into his hand whether it produces a sensibility equal to or under the standard. This, too, is a result pre-eminently intellectual in its nature; the process of acquisition that brings it about, ranks as a fundamental property of our intelligence. The sensibilities that can assume this permanent character, so as to be used in comparison, without reference to their original cause, are truly intellectual sensibilities. The sense of difference or degree in resistance is more endurable, more recoverable, more independent of the actual pressure, the real presence of the objects, than the emotional excitement, the pleasure or pain of intense muscular action. Of two burdens that stimulated an intense emotion of active expenditure, we can more easily retain the fact of one being greater than the other, or the sensibility that would enable us to compare some new and present burden with them, than we can realize over again all the vehement sense of exertion, the intense feeling the perspiration and the heat that, constituted the pleasure or the pain of the moment The mere sense of the difference is evidently a small and limited portion of the entire conscious state; and for that reason alone it would be more revivable. To re-agitate the whole frame with the entire current of that feeling, perhaps at a time when the state of the body and mind is unfavourable to it, cannot be so easy as to revive a portion of the sensibility that is not connected with much excitement. It is not necessary to revive the whole in order to revive the measure or estimate of the whole, and that portion sufficing for the comparative estimate is the portion available for the purpose now under consideration.

The sensitiveness to relative weight, or to things compared together, may not imply great sensitiveness to absolute weight, proceeding upon the engrained impression of the standard.

Although the use of the balance supersedes to a very great extent the sensibility to weight residing in the muscular system, there are occasions where this sensibility can display its acuteness. In many manual operations, weight is often estimated without the aid of the balance. In throwing a missile to reach a mark, an estimate of weight must enter into the computation of the force expended.

In appreciating the cohesivenes, of tenacious bodies—the thickness of a dough, or the toughness of a clay—the same sense of resistance comes into operation. In like manner the elasticity of elastic substances—the strength of a spring, the rebound of a cushion—comes to be discriminated with more or less nicety.

23. The second mode of muscular action is the Continuance of it. A dead strain of unvarying amount being supposed, we are differently affected according to its duration. If we make a push lasting a quarter of a minute, and after an interval renew it for half a minute, there is a difference in the consciousness of the two efforts. The endurance implies an increased expenditure of power in one mode, and we are distinctly aware of such an increase. We know also that it is not the same as an increase in the intensity of the strain. The two modes of increase are not only discriminated as regards degree, they are also felt to be different modes. The one is our feeling and measure of Resistance or Force, the other, stands for a measure of Time. All impressions made on the mind, whether those of muscular energy, or those of the ordinary senses, are felt differently according as they endure for a longer or a shorter time. This must be true of the higher emotions also. The continuance of a mental state must be discriminated by us from the very dawn of consciousness, and hence our estimate of time is one of the earliest of our mental aptitudes. It attaches to every feeling that we possess, although we do not always exercise the power of making this special comparison, and commit mistakes in consequence.

The estimate of continuance thus attaches to dead resistances, but not to that alone. When we put forth power to cause movement, as in lifting a weight off the ground, or in pulling an oar, we are aware of a difference in the continuance of the movement. We also know that we are moving, and not simply resisting. The two modes of exercising force are not confounded in our consciousness; we hold them as different, and recognise each when it occurs. Now the continuance of movement expresses more to us than the continuance of a dead strain. It is the sweep of the organ through space, and connects itself, therefore, with the measure of space or extension. The range of a muscle's contraction, which is the same as the range or extent of motion of the part moved, is appreciated by us through the fact of continuance. Being conscious of a greater or less continuance of movement, we are prepared for estimating the greater or less extent of the space moved through. This is the first step, the elementary sensibility, in our knowledge of space. And although we must combine sensations of the senses with sweep of movement in our perception of the extended, yet the essential part of the cognition is due to the feelings of movement. We must learn to know, by a process to be afterwards adverted to, the difference between the co-existing and the successive, between Space and Time; and we can then, by muscular sweep—that is, by the continuance of muscular movement—discriminate the differences of extended matter or space. This sensibility becomes a means of imparting to us in the first place the feeling of *linear extension*, inasmuch as that is measured by the sweep of a limb, or other organ moved by muscles. The difference between six inches and eighteen inches is represented by the different degrees of contraction of some one group of muscles; those, for example, that flex the arm, or in walking, those that flex or extend the lower limb. The inward impression corresponding to the outward fact of six inches in length, is an impression arising from the continued shortening of a muscle. It is the impression of a muscular movement having a certain continuance; a greater length is a greater continuance.

The discrimination of length in any one direction obviously includes *extension* in every direction. Whether it be length, breadth, or height, the perception has precisely the same character. Hence superficial and solid dimensions, the size or magnitude of a solid object, come to be felt through the same fundamental sensibility to expended muscular force. But this will be understood more fully, when we consider muscularity as combined with the senses of Touch and Sight.

By the muscular sensibility associated with prolonged contraction, we can thus discriminate different degrees of the attribute of space, in other words, difference of length, surface, and form. When comparing two different lengths, we can feel which is the greater, just as in comparing two different weights or resistances. We can also, as in the case of weight, acquire some absolute standard of comparison, through the permanency of impressions sufficiently often repeated. We can engrain the feeling of contraction of the muscles of the lower limb due to a pace of thirty inches, and can say that some one given pace is less or more than this amount. According to the delicacy of the muscular tissue, we can, by shorter or longer practice, acquire distinct impressions for every standard dimension, and can decide at once as to whether a given length is four inches or four and a half, nine or ten, twenty or twenty-one. This sensibility to size, enabling us to dispense with the use of measures of length, is an acquirement suited to many mechanical operations. In drawing, painting, and engraving, and in the plastic arts, the engrained discrimination of the most delicate differences is an indispensable qualification.

24. Under the foregoing head we supposed the case of steady or uniform movement; and called attention to the power of discriminating the greater or less continuance of it. But movements may vary in their rate of speed; and it is now to be considered whether or not the mind is affected when the speed is increased or diminished. This is also a mode of expending additional power; and it is not possible for us to increase the expended energy without being conscious of the fact. The only doubt that can arise is as to our being able to distinguish the various modes of increase—increase in the dead strain at any one instant, increase in the duration of the strain, increase in the duration of a movement, increase in

the velocity of the movement—so as to be aware which mode we are under for the time. If we confounded all these modes of increase under a common impression of intensified energy, our muscular discrimination would be wholly inadequate to the perception of the external world; and, in particular, our ability to estimate extension would have to be referred to some other part of our constitution. But it is quite certain that we are differently affected under these various situations. Our consciousness is not the same when we augment the energy of a dead resistance, as when we protract the time of that resistance; nor is it the same when we prolong the duration of a uniform movement, and when we add to its speed. We must be supposed to be aware, when we accelerate our pace, not merely that more power is going out of us, but that such power is in one especial mode, which we distinguish from other special modes. This being assumed, we are cognisant of degree in the rapidity of our movements, and so possess the power of estimating another great property of moving bodies, the velocity of their motions. This measure is taken first on our own movements, and thence extended to other moving things that we encounter. When we follow a moving object with the hand, or with the eye, or keep pace with it, its velocity is transferred to ourselves, and estimated accordingly.

The feeling of the rapidity of muscular contraction has a further office. It is an additional means of measuring extension. An increase of velocity in the same time corresponds to an increase of range or extension, no less than the same velocity continued for a greater time. Extent of Space thus connects itself with two separate discriminations—Continuance, and Velocity, of movement.

The characteristic sensibilities of the different kinds of movement, as formerly explained, whereby we are so differently affected according as movement is slow or quick, are thus of great intellectual importance, as enabling us to be characteristically impressed by each varying degree of velocity. The soothing tendency of the slow motions, and the exciting effect of the comparatively rapid motions, are instrumental in enabling us to discriminate degrees of velocity directly, and of space indirectly.*

* A fourth variety of muscular discrimination may be pointed out as in constant use, namely, the sense of the amount of contraction of a muscle, and of the position of the limb in consequence. We are ordinarily aware not merely that we are putting forth a force of a certain degree and continuance, but that we are operating either at the beginning of the muscle's contraction, so to speak, or at some advanced stage of the contraction. This determines, of course, the attitude or position of the part moved. We know, in exerting the arm in the dark, whether it is extended or bent, and whether it is thrown before or behind. We know in grasping anything in the hand, whether the hand is very much stretched, or very much closed; and we can judge of the different degrees of contraction determining intermediate positions.

By this sensibility we are able, after experience, to estimate the magnitudes of bodies without moving the arm or the hand, or other organ. By the mere stretching of the arms, without attending to the movement implied in that stretch, we measure in our mind the length of an object, or of an interval. By the dead span of the fingers and thumb, we can estimate any length that is within the scope of the parts.

It is usual to describe this particular discrimination as a sense of the state of the muscle's contraction, and to regard it as the primary or typical form of the muscular sense. Now the discrimination must be an original fact; one cannot see how it could be acquired; but the *meaning* given to it, the interpretation of the position of the limb, and of the magnitudes embraced between two outstretched parts, is wholly acquired. We must learn by experience what movements correspond to the transition from one mode of contraction to the other; extension must be measured first by movement. A definite fixed position of the two arms, of the two legs, of the jaws, of the lips, or of the fingers and thumb, comes to represent a series of movements, and the corresponding estimate of space passed over by movement. With one hand resting upon one side of a box, and the other resting upon the top, we can tell the inclination of the two sides without movement; our experience has made the feeling of certain combined dead tensions, a symbol of a series of movements in different directions.

The importance of this mode of discrimination is perhaps best seen in the eyes. It enters into the explanation of the binocular feeling of solidity.

I have not inserted this feeling in the text among the fundamental discriminations of muscle, because it seems bound up with our sensibility to movement. If I were to assume the sense of the state of contraction as the primary feeling, the sense of movement would follow; since movement implies that the muscle passes through a series of states of contraction, and the conscious sequence of these states would be the mental fact of movement. It is possible that the feeling of movement may consist of the primary feeling of ex-

We have thus gone over the two great classes of muscular feelings enumerated at the outset of the chapter.* This fundamental sensibility of our nature will come up again in a variety of connections, and much has still to be said in order fully to explain the growth of the perceptions of Externality, Force, Space, and Time.

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pended energy (given in its purity in dead resistance), modified by a muscular sensibility arising in the change from one stage of contraction to another. But, be this as it may, I think it enough to assume as distinct and fundamental the modes of muscular discrimination discussed in the text.

* Sir William Hamilton, in his Dissertations on Reid, p. 864, has drawn a distinction between what he calls 'the locomotive faculty,' and the muscular sense, maintaining that the feeling of resistance, energy, power, is due to the first and not to the second. By this locomotive faculty he means the feeling of volitional effort, or of the amount of force given forth in a voluntary action; while he reduces the application of the term 'muscular sense' to the passive feeling that he supposes us to have of the state of tension of the muscle.

His words are: 'It is impossible that the state of muscular feeling can enable us to be immediately cognizant of the existence and degree of a resisting force. On the contrary, supposing all muscular feeling abolished, the power of moving the muscles at will remaining, I hold that the consciousness of the mental motive energy, and of the greater or less intensity of such energy requisite, in different circumstances, to accomplish our intention, would of itself enable us always to perceive the fact, and in some degree to measure the amount, of any resistance to our voluntary movements; howbeit the concomitance of certain feelings with the different states of muscular tension, renders this cognition not only easier, but, in fact, obtrudes it on our attention.'

The sense of expended energy I take to be the great characteristic of the muscular consciousness, distinguishing it from every mode of passive sensation. By the discriminative feeling that we possess of the degree and continuance of this energy, we recognise the difference between a greater and a less stretch of muscular tension, and this appears to be the *primary* sensibility operating in the case. The other sensibilities of muscle, derived through the sensitive fibres, may aid us in the important discriminations between the different *modes* of increased energy above specified.

I may here express the obligations we are under to Sir William Hamilton for his historical sketch of the doctrine of the Muscular Sense, contained in the same note; which is not the least valuable and interesting of his many contributions to the history of mental and metaphysical science.

CHAPTER II.

OF SENSATION.

BY Sensations we understand the mental impressions, feelings, or states of consciousness, resulting from the action of external things on some part of the body, called on that account sensitive. Such are the feelings caused by tastes, smells, sounds, or sights. These are the influences said to be external to the mental organization ; they are distinguished from influences originating within, as, for example, spontaneous activity, the remembrance of the past, or the anticipation of the future.

The Sensations are classified according to the bodily organs concerned in their production; hence the division into five senses. But along with distinctness of organ, we have distinctness in the outward objects, and also in the inward consciousness. Thus objects of sight are different from objects of smell ; or rather we should say, that the properties and the agency causing vision are different from the properties causing smell, taste, or hearing.

The difference of the mental feeling or consciousness in the various senses is strongly marked, being a more characteristic and generic difference than obtains among the sensations of any one sense. We never confound a feeling of sight with a feeling of sound, a touch with a smell. These effects have the highest degree of distinctness that human feelings can possess. The discrimination of them is sure and perfect.

We are commonly said to have five Senses, these being apparent to every observer : Sight by the eye, Hearing by the ear, Touch by the skin, Smell by the nose, Taste by the mouth, In addition to these, physiologists distinguish a sixth sense, of a more vague description, by the title of *common* or *general sensibility*, as will be seen in the following extract from Messrs. Todd and Bowman. 'Under the name of *common* or general sensibility may be included a variety of internal sensations, ministering for the most part to the organic functions and to the conservation of the body. Most parts of the frame have their several feelings of comfort and pleasure, of discomfort and pain. In many of the more deeply seated organs no strong sensation is ever excited, except in the form of pain, as a warning of an unnatural condition. The internal sensations of warmth and chillness, of hunger, thirst, and their opposites, of nausea, of repletion of the alimentary and genito-urinary organs, and of the relief succeeding their evacuation, of the privation of air, &c., with the bodily feelings attending strongly excited passions and emotions, may be mentioned among the principal varieties of common sensation.'

In this enumeration we can see several distinct groups of feelings, and can refer them to distinct bodily organs. Hunger, thirst, their opposites, nausea, repletion, and evacuation of the alimentary tube, are all associated with the *digestive* system. They might therefore be termed the digestive sensations. The privation of air causes a feeling whose seat is the lungs, and is one kind of sensibility associated with *respiration*. The sensations of warmth and chillness connect themselves with the skin, with the lungs, and with the organic processes in general. The genito-urinary organs have a class of feelings so very special and peculiar, that they had better not be included under common sensibility.

Looking at the very important classes of feelings here indicated, important at least as regards human happiness and misery, considering also that they are but a few examples chosen from a very wide field, I consider it expedient to describe them in systematic detail. It is the business of a work like the present to review the entire range of human sensibility, in so far as this can be reduced to general or comprehensive heads; and the only question is, where ought these organic feelings to be brought in? I know of no better arrangement than to include them among the Sensations. The only objection is the want of outward objects corresponding to them in all cases. The feelings of comfort or discomfort arising from the circulation, healthy or otherwise, are not sensations in the full meaning of the term; they have no distinct external causes like the pleasures of music, or the revulsion of a bitter taste. But the reply to this objection is, first, that in most cases, if not in all, an external object can be assigned as the stimulus of the feeling; for example, in the digestive feelings, the contact of the food with the surface of the alimentary canal, is the true cause or object of the feeling In like manner, the respiratory feelings may be viewed as sensations having the air for their outward object or antecedent. And with reference to the cases where feeling cannot be associated with any external contact, as in the acute pains of diseased parts, we may plead the strong analogy in other respects between such feelings and proper sensations. In all else, except the existence of an outward stimulus, the identity is complete. The *seat* of the feeling is a sensitive mass, which *can* be affected by irritants external to it, and which yields nearly the same effects in the case of a purely internal stimulus. So much is this the fact, that we are constantly comparing our inward feelings to sensations; we talk of being oppressed, as with a heavy burden, of being cut, or torn, or crushed, or burned, under acute internal sensibility. Taking all these considerations together, I have resolved to class these feelings with sensations, and to place them first in the order of the Senses, under the title of Organic feelings, or Sensations of Organic Life.

In the Senses as thus made up, it is useful to remark a division into two classes, according to their importance in the operations of the Intellect. If we examine the Sensations of Organic Life, Taste, and Smell, we shall find that as regards pleasure and pain, or in the point of view of Feeling, they are of great consequence, but that they contribute little of the permanent forms and imagery employed in our Intellectual processes. This last function is mainly served by Touch, Hearing, and Sight, which may therefore be called the Intellectual Senses by pre-eminence. They are not, however, thereby prevented from serving the other function also, or from entering into the pleasures and pains of our emotional life.

SENSATIONS OF ORGANIC LIFE.

1. The classification of these is best made to proceed according to the parts where they have their seat. We have already mentioned the organic feelings connected with one tissue, the *muscular;* we shall now have to describe them in full. We must also notice the other tissues entering into the moving apparatus, namely, the *Bones* and *Ligaments.* The *Nerves* and *Nerve Centres* are subject to feelings dependent on their stimulation, growth, and waste, and on the changes that they go through in health and disease. The *Circulation of the Blood*, with the accompanying processes of secretion, assimilation, and absorption, may be presumed to have a distinct range of sensibility. The feelings connected with *Respiration* are of a less ambiguous character than the foregoing. The sensations of *Digestion* are numerous and prominent.

I. *Of Organic Muscular Feelings.*

2. In a quotation given from Dr. Sharpey, it is remarked that muscular sensibility 'is manifested by the pain which is felt when a muscle is cut, lacerated, or otherwise violently injured, or when it is seized with spasm.' These forms of pain are so many states of consciousness, having their seat or origin in the muscular tissue; the integrity of the nerves and nerve centres being likewise essential to this, as to every other kind of sensibility.

Now that we have come to describe the states of feeling arising through the Senses, named Sensations, we shall have to assign in each case the external agent that causes the Sensation (light, sound, &c.); to follow this up with an account of the action or change effected on the sensitive surface, (as the skin, the tongue, &c.); and then to proceed with a delineation of the feeling itself, according to the plan already laid down.

In the case of the proper muscular sensibilities described in the foregoing chapter, an external agent could not be assigned in the same sense as light is to the eye, or hard surfaces to the skin. But with reference to the first class in Dr. Sharpey's enumeration, 'cuts, lacerations, and violent injuries,' we discern both an external agent and an assignable change in the substance of the muscle. There is in those circumstances a sudden break in the continuity of the fibre, which is an effect productive of pains in almost any tissue of the body. This is manifestly one of the effects calculated to give an intense shock to the nerves, originating a most energetic and pungent stimulus, which is transmitted to the centres, and there wakens up both consciousness and activity in very violent forms.

Such being the bodily Origin, let us complete the consideration of the physical side, by attending to the outward effects, or embodiments, constituting the Expression of the feeling. And the remarks on this point, as well as the further delineation of the conscious state, will serve to typify acute physical pains generally.

It is well known that a characteristic expression attends acute pains. The features are violently contorted, the voice is excited to sharp utterances, the whole body is agitated. Sometimes the ordinary movements are quickened; at other times contortions and unusual gestures are displayed. It would appear that the agency that causes the pain is such as to stimulate to an intense degree the whole moving system. Indeed, the infliction of pain (within limits) is one of the customary modes of rousing an animal or a human being from lethargy to activity. There is also a well known form of the countenance that marks the condition of pain, being produced by certain movements of the mouth, nostrils, and the eyes, to be afterwards analysed; but whatever be the direction given to these movements, they are marked by the characteristic of violence or intensity.

The accompaniment of sobbing shows that the involuntary muscles and glands are also affected.

But we should give a most inadequate account of the embodiment of pain if we fail to note the successive stages of the manifestation. While the first shock may have all the characters of violence and exalted energy now mentioned, there follows after a time a state of prostration and exhaustion, showing that these lively manifestations were no proof of an increase of vital energy on the whole. So far from that being so, it is demonstrable that there is a great decrease of vital energy on the whole. Violent movements of any kind soon wear out the strength; but the depression of vital energy in all parts of the system—organic functions as well as muscles—after an attack of pain, is much beyond what would follow from the same discharge of muscular energy in the absence of pain. This is a most material consideration, which is not to be disguised by the show of increased energy in the early stages. The director of the medical staff of the British Army in the Crimea, was certainly in error when he discouraged the use of chloroform in surgical operations, on the ground that pain is a stimulant. If the termination is taken into account as well as the beginning, pain in every form, so far from being a stimulant, destroys the vital energies. Not only does muscular exhaustion follow, but the organic processes—the circulation, respiration, and digestion—are greatly enfeebled, an effect that does not usually result from mere violence of bodily movement.

These bodily manifestations, which are the natural accompaniment of acute pain (arising as an effect of the same cause), by being freely indulged in, operate as a diversion and a relief to the mental system. There is probably a physical sequence in this fact also. Great muscular exertion drains off the circulation from the brain to the muscles; and the effusion of tears would appear to have a like effect. The advantage, however, is only temporary; in the end the exhaustion is only aggravated by giving full vent to the manifestations.

3. To pass now to the Mental side, or the character of the states in question, viewed as Feelings: we know each one by his own consciousness, what they are; and they are generalized, pointed out, and understood, by such names as pain, suffering, agony, torture.

The *quality* of the feeling is pain. The *degree* is intense or acute. The measure is obtained in a two-fold manner: by comparing the pain with other pains, and by the amount of pleasure that it can neutralise. Taken in both ways, we consider the sufferings of wounds, lacerations, and acute derangements of our sensitive tissues, to rank among our greatest sufferings, our worst miseries. As respects *specialities* of character, we find language employed to discriminate the nature of different pains. A cut or a scald is different from a fit of rheumatism or gout. Neuralgia is different from the electric shock. We describe the varieties by such epithets as burning, shooting, racking; and there is a pathological interest in noting these distinctions.

Pain is apt to rouse some special emotion, varying with the general temperament of the individual. Grief, terror, or rage, may prevail according to the circumstances, there being a natural connection between the shock of acute suffering and all these passions; the implied destruction of the opposite modes of mind being equally attested by facts.

Our plan of description requires us next to advert to the Volitional characteristics of acute pain. The general principle of volition, as applied to pains, holds in this instance. Such pains, in proportion to their intensity, stimulate us to efforts for mitigating and putting an end to them when present, and for avoiding them when there is danger of their occurrence. The peculiarity of the case that most deserves notice is, that as, for a time, they are stimulants of activity, the disposition to work for their abatement is very powerful at first, but fails at last with the prostration of the energies. The effective force of our volitions depends much upon the active power of the system at the moment; and a state that increases this power, even by a wasteful stimulation, reaps the benefit of that increase, while anything that depresses and destroys the vital functions, as severe pain does on the whole, so far to that extent paralyses the action of the will. Hence, although a passing smart may waken up the activity, an intense and continuing pain has an opposite effect.

The movements that constitute the proper emotional manifestations, are apt to be mixed up and complicated with movements directed by the will with a view to relief. It is generally easy to discriminate the two classes, and it is important for understanding our mental structure that they should be discriminated. The volitional movements are such as are maintained solely because they bring a felt alleviation. If any specific posture is of this character, it is energetically adhered to; and if the mere vehemence of the outburst is found to deaden our sensibility to the pain, we are induced thereby to keep up the gesticulations prompted in the first instance by the emotional wave. Even in the lower animals, when we witness the convulsions that follow a shock to the physical system, we may satisfy ourselves as to the existence of true volitional movements, in company with the demonstrations that are the proper embodiment of the pain.

If we wish to measure the volitional urgency of a feeling, we can adopt the same mode of comparison as that suggested for the degree of pleasure or pain. When two feelings prompt in opposite ways, the one that determines the conduct is said to be volitionally the stronger.

There remains now the bearing of the feelings in question on the Intellect. Here, as in the Will, there is a general principle, liable to exceptions and modifications according to the circumstances of each particular case. The principle is that feelings are discriminated, identified, and remembered according to their degree, whether in intensity or in quantity. This law holds within a moderate range of excitement. A very feeble impression cannot be nicely discriminated, and is little remembered. But the limitation arises when the degree is excessive and overpowering. There is a pitch of physical agony that overpowers the purely intellectual function of discrimination; and although retentiveness is stimulated by intensity, the remembrance becomes more and more inadequate to the fullness of the reality. Not only are we unable to re-instate the acuteness of the suffering, but we are unable to figure to ourselves even the character of the pain, until it has become familiar by many repetitions. When the same, or nearly the same, pain recurs, we can mark the agreement, which is a true intellectual function, requiring for its exercise the retentive property also ; but we have little power of remembering or imagining the peculiar features, or the charateristic consciousness of an acute misery.

A good retentiveness for acute pains has not that intellectual importance possessed by the memory for sights and sounds, but it has a twofold practical importance. In the first place, the exercise of the will in the way of prevention depends on it. When a feeling ceases in the actual, it can have no volitional power, except as it is vividly presented in idea ; and on this ground, the more lively the recollection, the more energetically will we be moved in our precautionary labours as regards the future. The degree of retentiveness for pain is thus the intellectual foundation of Prudence. It is, in the second place, the foundation of Sympathy, or the power of entering into the feelings of others when suffering under a like infliction.

4. The muscular pains that have been the subject of the above description, were those arising from cuts, lacerations, and violent injuries, being the incidents that all the tissues are liable to. (I do not here discuss the question raised by some physiologists, as to whether it is the proper muscular substance that is sensitive, or whether the pain is owing to the injury done to the nerve fibres). We did not include the characteristic pain of muscle—*cramp,* or spasm—which demands a separate mention. Cramp is well known to be a violent contraction of a muscle, in whole or in part, due to some irritation of the motor nerves that supply the muscle. It is a contraction probably far beyond what can be induced by a voluntary effort, and does not relate itself in any way to a power consciously proceeding from the brain. The state of cramp acts violently upon the sensitive fibres of the muscle ; and, according to Dr. Brown-Séquard, the pain is in proportion to the resistance offered to the muscle's contraction. 'I suppose,' he says, 'a case of painful contraction of the anterior

muscles of the thigh; the pain is increased every time the contracted muscles are elongated; *i. e.*, when the resistance to the contraction is augmented; on the other hand, it diminishes when the resistance to the contraction is rendered less than it was, and, at last, *it disappears entirely, or almost entirely, when the resistance is completely, or almost completely, destroyed.*'—(Lectures, p. 7.) The pains in the uterus are of the nature of spasm, and are relieved by the discharge of the contents. An explanation is now afforded of what was at first considered a paradoxical fact, the production of pain by stimulating the anterior, or the motor, roots of the spinal nerves. The effect of such stimulation is to contract the muscles, not in that measured and moderate degree occurring in their contraction by the will, but with the violence of cramp, thereby imparting a shock to the sensitive nerves of the muscle. When the posterior, or sensitive, roots of the nerves are cut, the pain appears no longer. These explanations are interesting, as they remove what seemed serious objections to the great discovery of Sir Charles Bell.

The involuntary muscular fibres of the alimentary canal are also liable to cramp.

It is not requisite to repeat the particulars of the systematic description for this peculiar case. It ranks with the class of acute pains in all the general characters. But it is, perhaps, in its nature the most acute and violent of any. We can discriminate it from cuts, scalds, inflammations, and sores; the familiar name 'racking' pain describes and classifies it. Wherever we have the experience characterised by this epithet, it is probable that the seat is in the muscles, and that the action is cramp or spasm. The involuntary muscles of the uterus and of the alimentary canal occasion the most aggravated forms of the pain.

5. Another class of feelings connected with the muscles may be specified under the same general head of Organic Feelings, those arising from *over-fatigue*. This cause is known to produce acute pains of various degrees of intensity, from the easily endurable up to severe suffering. It is not necessary to advert to these more specifically, they being suf-

ficiently comprehended by referring them to the genus of acute pains of the muscles.

Very different is the state of feeling produced by mere *ordinary fatigue,* which we may introduce in the present connection. This is a state not at all painful, but the opposite. It is one of the pleasurable experiences allied with the muscular system.

The antecedent cause of the state is exertion, or the repeated contraction of the muscle up to exhaustion. Of the peculiar condition of the tissue in this state we are unable to speak with any precision; some chemical change has taken place in the muscular tissue, disposing it to inaction for a time, and to the absorption of nutriment.

In this case, there is a pleasurable Feeling, more massive than acute. If a considerable number of the larger muscles have been in exercise, the sensibility is proportionably great. Various elements may enter into the effect. The circulation of the blood, directed strongly for a time to the muscular tissue, now returns in a more liberal supply to the other organs,—the brain, the stomach, &c., and the general sensibility of the system is increased. There is, in the next place, an agreeable reaction from what may have been the commencing pains of fatigue. Allowing for these two collateral effects, we are still to suppose that the muscle itself gives rise to a certain pleasurable feeling when in this state. The degree of it may be, on the whole, considerable; it is one of the pleasures of a life of hard exercise or bodily toil, and taken along with the luxurious slumbers and the general sensation of health following in its train, it must be regarded as an appreciable fraction of human enjoyment.

The connection already remarked on between slow movements and approaching sleep, extends also to muscular repose and sleep. The massive sensation experienced as we fall asleep, has its seat in no inconsiderable degree in the muscular tissue, especially after hard exercise, when this sensibility is most powerfully manifested.

6. I will pass over with very few remarks the *Bones* and

Ligaments. Their sensibility is exclusively connected with injury or disease, appearing in that case under the form of acute pain, a form of sensibility that it will suffice to have dwelt upon once for all. The minute discrimination of forms of pain is highly serviceable to the physician, and, if susceptible of being accomplished with precision, would enter with propriety into a systematic delineation of the Human Mind at present we require only to remark, that sensibility everywhere demands a distribution of nerve fibres, and that the bones and ligaments are supplied with these; and although not in great number, they are yet sufficient to agitate the nerve-centres with overpowering intensity on particular occasions. The diseases and lacerations of the periosteum give birth to excessive pains. The ligaments are said to be insensible to the cut of a knife, while the feeling of their being wrenched is most acute and painful. In extreme fatigue, the ligaments and the tendons of the muscles would appear to conspire with the muscular tissue, in giving rise to the disagreeable feeling of the situation. The joints are noted on various occasions as the seat of pain; in gout, for example. The diminution of atmospheric pressure consequent on ascending a great elevation, causes an intense feeling of weariness in the hip joints. This is shown by experiments to be a muscular pain. The rarefaction of the air diminishes the support of the limb, and it falls down in the joint by its own weight, thereby becoming an additional burden to the muscles. Fracture of the bones and laceration of the ligaments, are among the most agonizing misfortunes of our precarious existence.

Organic Sensations of Nerve.

7. The nerves and nerve centres, apart from their action as the organs or medium of all human sensibility, have a class of feelings arising from the organic condition of their own tissue. Wounds and diseases of the nerves are productive of intense pains, witness tic-douleureux and the neuralgic affections of the brain and spinal cord. Nervous exhaustion and

fatigue produces a well known sensibility, very distressing in its extreme forms; and repose, refreshment, and stimulants engender an opposite condition through a change wrought on the substance of the nerve tissue.

The nervous pains arising from cuts, injuries, and disease of the substance are characterised by a most vehement intensity. It would appear that a conducting nerve fibre can be powerfully agitated by the irritation being directly applied to itself. When a muscle is spasmodically contracted, the influence passes from the muscular fibre to the nerve, and the affection of the nervous fibres may then be supposed to be secondary; but in neuralgic affections the influence comes at first hand, and not by propagation from some other tissue.

We have here, therefore, a manifest complication to deal with. The nervous substance is necessary to all sensibility, and, strictly speaking, every form of pleasure and of pain is physically embodied in a certain condition of the brain and nerves. But we have to note, under the present head, the effects that arise from operating upon the tissue directly, and not through the organs of sense, or by means of the emotions. This direct action is exemplified in injuries and in diseases of the nerves; in the use of stimulating drugs; and in the agencies whereby the cerebral substance is nourished or impaired.

8. *Nervous fatigue* and exhaustion, when carried beyond a certain pitch, is an extremely trying condition. It is produced by excessive expenditure, in one or other of the forms of nervous exercise; by intense pains, by excess of pleasure even, by over-much thought, or by too long continued activity of either body or mind. The effect is doubtless to modify the nerve substance and its circulation, but in what precise way we cannot undertake to point out. The resulting sensation can be more readily described. The most painful aggravation of the state occurs when a morbid activity is generated beyond the control of the individual, hurrying him for a time into still greater depths of painful exhaustion.

This state of mind merits a full and orderly delineation.

Commencing as usual with the great characteristic distinction of pleasure and pain, we must attribute to it an exaggerated form of the latter. This pain is marked not by acuteness or intensity, but by massiveness or quantity. It is a wide spread and oppressive sensation, seeming to involve the entire nervous system. Its peculiar character or tone cannot be seized by any descriptive phrase. I must appeal to each person's own experience for the perception of it. The re-action of an intense excitement, the exhaustion of a severe loss or grievous mortification, will bring up an instance of it to most minds. It will also be illustrated by contrast with the opposite state to be next treated of. The expression of the feeling is one of pain, not acute, but deep seated and engrossing; collapsed features, restlessness, fretting, and melancholy. The actions prompted are usually something quite extravagant and misplaced: the getting rid of life itself is suggested when the condition assumes its most virulent forms. This is a proof of the total loss of freshness and health through the substance of the nervous system. Hence the final triumph of ennui :—

I am aweary, aweary, O God that I were dead!

It is too powerful to be easily remembered when the reality has passed away. The most obvious comparison that the state suggests is to excessive burden or toil in the moving organs.

To fix by a precise delineation this condition of organic nervous exhaustion is an extremely important attempt, notwithstanding the difficulties arising both from the imperfection of our language, and from the fluctuation and various nature of the condition itself. The importance lies in this great fact, that the state is the termination or final issue of a great many other forms of pain. The struggle that we maintain against painful inflictions of all kinds, whether bodily or mental, preys at last on the substance of the nervous system, and produces as its result this new form of evil. Hence the common source of complaint with all classes of sufferers,—the weariness, the ennui, the heavy tread of time, the impatience, the impossibility of being effectually soothed or comforted.

9. The consciousness arising out of the *healthy and fresh condition of the nerve tissue,* or out of the operations of the various artificial stimulants, is the exact contrast of the state now described. I do not inquire into the use and abuse of those stimulating materials, but merely advert to the effect common to them all, and for which they are had recourse to; an effect also to be reaped from the natural condition of the nervous organs when in their vigour, as may be seen more particularly in early life.

Following a parallel course of description, we may say of the state in question, that the outward causes or antecedents are either healthy agents, or stimulants and drugs; and that the change in the tissue is of a physical nature, but not capable of being otherwise specified. The consciousness itself is pleasurable, and may ascend to very high degrees of pleasure, both in acuteness and in mass. The action and desire that it prompts are naturally for continuance unlimited, and the cast of thought is hopeful for the future, The intellectual persistence is, as in the other case, low; that is to say, the state is one difficult to be remembered or imagined when once entirely gone, and when either the opposite condition, or some intermediate neutral one, has taken the place of it.

Organic Feelings of the Circulation and Nutrition.

10. The circulation of the blood through the arteries and veins by the force of the heart, the secretion of nutritive material and of excrementitious matter in the several tissues and glands, and the various acts of absorption corresponding to those processes—cannot be unattended with feeling. But the sensation arising out of the different degrees of vigour attending this course of operations, is both vague and difficult to isolate. We may surmise with some probability that the depression of a low pulse and languid circulation has its seat in the capillaries situated all over the body, or is a sensation

of the circulating machinery. In this connection, we may allude to the two formidable experiences of Thirst and Inanition, or privation of Food.

Thirst shows itself in a dryness of the mouth and throat, accompanied by a feeling of roughness and burning in the hinder walls of the gullet or the palate, and in the roots of the tongue. It is connected with a deficiency of water in the blood, as compared with the solid constituents. Hence it is brought on by profuse perspiration, by inhaling dry air, by taking solid food, and by partaking of saline or other matters that strongly attract water to themselves. It is sometimes present as a sensation when the mouth is not parched, and absent in the opposite case; this would imply some deranged state of the nerve centres.

Inanition is different from hunger; still, as regards their physical foundations, the two may be taken together when we come to speak of Digestion.

The feelings of Inanition and of Thirst, when carried to the extreme, are states of pervading, massive, deep, and intolerable wretchedness. They are far more intense than mere nervous depression, and therefore stimulate a more vehement expression and a more energetic activity. Even when not accompanied with the terror of death, they excite lively and furious passions. The unsophisticated brute is the best instance of their power. Like other organic states, they are not very easily realized after they are gone, but the fear, and stir, and energy that they produce at the time, leave a much more lasting impression than mere low spirits; we take far greater precautions against them than against nervous depression, which last is perhaps the least provided for of human pains.

The consciousness growing out of a vigorous circulation, with all that this implies, may be looked upon as the most characteristic sensation of pure animal existence. It is more continuous and persistent than good innervation, sound digestion, or than most of the other organic states. There is a thrill of corporeal gratification, not very acute, but of considerable volume, a gentle flow felt everywhere, rendering existence enjoyable, and disposing to serene and passive contentment.

> Let me have men about me that are fat;
> Sleek-headed men, and such as sleep o' nights.

It seems to be through the circulation that we are sensitive to atmospheric changes, more particularly as regards moisture and dryness. It is found that in a dry atmosphere the capillary circulation is quickened, and in a moist atmosphere retarded. The influence of heat and cold probably extends to the circulation and the nutritive functions.

Feelings of Respiration.

11. 'Respiration is that function by which an interchange of gases takes place between the interior of an organized being and the external medium; and, in the animal kingdom, oxygen is the gas received, and carbonic acid the gas given out.' The aeration of the animal fluids or juices is an essential of their vitality; if this is put an end to, death ensues instantaneously; if insufficiently performed, the vigour of the animal is lowered, and a peculiar painful sensation experienced. In man and in air-breathing animals, there is a wind-apparatus, the lungs, inflated and contracted by muscles, so as to suck in and force out the air by turns.

In this action we have all the particulars necessary to constitute a Sense: *an external object*—the air of the atmosphere—which operates by physical contact upon the lining membrane of the tubes and cells of the lungs; *an organ of sense,* and a resulting *state of feeling,* or consciousness. The peculiarity of the case lies in its being almost entirely an emotional sense; generating feeling rather than yielding knowledge, or providing forms for the intellect; ranking, therefore, among the lower, and not among the higher, senses.

As respects the *object* of this sense, the external air, it need only be remarked, that the air differs considerably in its quality for breathing purposes, the chief point of difference being expressed by the term 'purity.' The purity is affected first by the loss of oxygen, which happens when the same air is repeatedly breathed, or otherwise consumed; secondly, by the accumulation of carbonic acid, from the same circumstance; and, thirdly, by the presence of foreign gases and effluvia arising from animal life, vegetation, or other causes. Closeness or confinement is the chief aggravation of all those impurities. Of the three evils—the loss of oxygen, the accumulation of carbonic acid, and the generation of effluvia of animal and other substances—the second is the least injurious; for, although the production of a carbonic acid atmosphere, by burning charcoal in a close room, is fatal to life, yet the quantity ordinarily occurring in rooms is not found to do any harm if mixed with air otherwise pure. The loss of oxygen, and the diffusion of the gases of decay, are the main influences that deteriorate the atmosphere.

Of the *organ* acted upon, the lungs, a minute description is not necessary for our present purpose. The structure is so arranged by ramifications and doublings as to present a very extensive surface to the air; the surface consisting of a thin membrane, with capillary blood-vessels, thickly distributed on its inner surface. The exchange of gases takes place through the double medium of membrane and capillary tube. The muscular apparatus for sustaining the bellows-action, is the diaphragm and abdominal muscles, and the muscles of the chest or ribs. The integrity and vigour of these muscles, and of the centres that sustain and time their action, must be reckoned as a condition of healthy respiration.

The respiratory nerve centres are stimulated from all parts of the body, but chiefly from those that, like the muscles, are large consumers of oxygen. The portion of the eighth pair of nerves named the nervus vagus, is instrumental in keeping up the rhythm of the lungs, and is also necessary to the feeling of suffocation.

The *feelings* of Respiration, both pleasurable and painful, are well marked. They include the gratification from pure air, enhanced by the increased action due to muscular exercise; the various shades of oppression, from over-crowded rooms and unwholesome gases; the distressing experience of suffocation; and the pains attendant on disease of the lungs.

12. The influence of pure and stimulating air abundantly inhaled, spreads far and wide over the system, elevating all the other functions by the improved quality imparted to the blood. The indirect consequences do not altogether hide the grateful sensibility arising from the lungs themselves, and referred by us to the region of the chest; a sensation not very acute or prominent, but possessing that choice and well known quality, expressed by the term 'freshness,' or 'refreshing.' This quality manifestly implies a contrast; for it is felt only when we pass from a lower to a higher degree of aeration. We may experience it at any time, by holding in the breath for a little, and then allowing it full play. No technical nomenclature can increase the conception possessed by every one of this remarkable sensibility; but for the sake of comparison with the other parts of our mental constitution, an attempt at verbal description is necessary. As just remarked, the sensation turns upon the contrast of the greater activity of the lungs with an immediately preceding activity of an inferior degree. It may be safely affirmed that no feeling arises from the lungs, after a given pace has been established for a length of time, but any acceleration of the rate of exchange of the two gases (by no means depending altogether on the rate of breathing) does for a time yield that delightful freshening sensation, which tells so immediately on the mental system as a contribution to our enjoyment, and as a stimulus to our activity and to our desire for rural recreation and bodily exercise.

13. The feelings of insufficient and impure air are manifested in the forms of faintness, sense of exhaustion and weariness, and are doubtless due, not to the lung-sense alone, but to the lowered condition of the body at large. The characteristic sensibility of the lungs is shown in the state termed *suffocation*, arising from the want of air, as in drowning, in an atmosphere deteriorated by poisonous gases, such as chlorine or sulphurous acid, in attacks of asthma, and in voluntarily

holding in the breath. 'After holding the breath for fifteen or twenty seconds during ordinary respiration, or forty seconds after a deep respiration, there arises an insupportable sensation over the whole chest, concentrated under the sternum, and no effort can maintain the interruption of the respiratory acts. This urgent sensation of want of breath, when carried to its full extent by any mechanical impediment to the aeration of the blood, is one of the most painful and oppressive kind, and is referable to the pulmonary plexuses (of nerves) distributed to the bronchia, and perhaps on the walls of the lobular passages and cells. The impression made on these peripheral nerves by the absence of oxygen, and the undue presence of carbonic acid in the air in contact with them, is propagated to the spinal cord and medulla oblongata by the sympathetic and vagus, and there excites those combined actions of the muscles of inspiration which lead to the renewal of the air.'* This sensation, so acutely painful, is aggravated, in the extreme cases, by the circumstance of growing worse every moment until relief or rupture ensue. It may rank as the most unendurable of all human sensations; while the circumstance that causes it, is especially fraught with danger to human life.

Feelings of Heat and Cold.

14. The description of these important feelings comes properly under Organic Sensations, since change of temperature affects all the organs of the body. Heat, or increased temperature, appears to abate the activity of the organic processes generally, with the exception of the skin, all whose functions are increased by it. Warmth induces in the skin a richer circulation and a greater activity in the sweat, and in the oil, glands. The various parts of the cuticle, the nails and the hair, are more abundantly produced. The sensory powers of the organ are greater, and the texture is softer and more polished.

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* Todd and Bowman, ii. 403.

Inasmuch as cold (not in excess) increases the activity of the muscles, the nerves, the respiration, and the digestion, the animal powers attain their maximum in cold climates, and in the winter season, allowance being made for constitutions unfitted to endure extreme depression of temperature.

Sudden changes of temperature derange the functions. A sudden increase will cause a slight feeling of suffocation, beating of the heart, and increased pulsation and respiration. A sudden chill makes breathing difficult, quick, and irregular, and increases the pulsations. The nerves lose their excitability under a great depression, or a great increase of temperature.

The feelings of heat and cold are very notable. Let us commence with *Cold*. The outward cause of this feeling is some influence tending to lower the temperature of the body. The natural heat of the blood is about 98°, and any contact below this point feels cold; any contact above it feels warm. There is a certain surplus heat generated in the human system, which enables us to live in a medium below 98°, without feeling cold, and if this heat be husbanded by clothing, a very great depression of external temperature may be endured. A room is warm at 60°. The outer air can be endured at freezing and far below, either by means of exercise, which evolves heat, or of clothing, which retains it.

An acute cold acts like a cut or a bruise, injuring the part affected, and producing intensely painful sensations of the class arising from violent local injuries. The temperature of freezing mercury would destroy the skin like boiling water or a sharp cut. This case needs not any special discussion at the present stage.

The proper sensation of Cold arises from a general cooling of the body, or any considerable part of it, below blood heat. The term 'chillness' expresses the state of feeling, which is of the painful class. The degree is not acute but massive. In its worst forms it is wretchedness in the extreme. To a person suffering from excessive chillness, some powerful stimulant, such as the taking of food, alcohol, or tobacco, is necessary to restore equanimity. The volition and the memory are proportionally impressed by the pains of cold, and they take a high rank in the reckonings of forethought and prudence.

It is a singular fact in our constitution that an agency calculated to quicken the vitality of so many leading organs —muscles, nerves, lungs, stomach—should affect us so powerfully, merely by the depression of one organ. The fact is highly illustrative of the importance of the skin, whether this importance be due to its organic functions or to its sensibility. Probably both circumstances enter into the case. It may be that the quickened vitality of all the other leading organs is unavailing for a perfectly healthy tone while the skin is depressed. But it must be also true that we are in a peculiar degree sensitive to changes in the condition of the skin, owing no doubt to its great supply of nerves.

15. The consequences of *Heat* are in nearly every particular the opposite of those now stated. Acute or intense heats agree with intense colds in being simply destructive and painful. Within the point of injury to the tissues, heat is a pleasurable sensation. The pleasure of heat, like the pain of cold, is voluminous or massive. There are cases, however, distinguished by intensity rather than by quantity; indeed, this distinction of quantity and intensity, used as a part of the description of feelings, has its perfect type in the case of temperature, there being a physical reality corresponding to the mental fact. Sometimes we have great intensity and small quantity, as in the scorching rays of a fire, or a cup of hot tea : at other times we have large quantity with low intensity, as in a hot bath, a warm room, a warm bed. The hot bath is the extreme instance. By no other contrivance can such a mass of heat be brought to bear upon the human system; consequently this presents the sensation of warmth in its most luxuriant form; a sensation cherished with intense avidity while it lasts, and surrendered with great reluctance. It is the intoxication of animal heat. We are unavoidably led to assume that this warmth must act powerfully on the

sensitive nerves; for it is hardly to be supposed, that the organic processes are so very much furthered by the sustained temperature, as to exalt the pleasurable consciousness to such a remarkable degree. Indeed, we may derange the system by excessive heat, without producing the painful feeling arising from cold; the instances of scorching fires, hot liquors, and a burning sun, will satisfy most people on this head.

In the case of morbid activity of the nervous system, warmth is a soothing influence, either by its physical effects, or by the nature of the sensation, or from both combined.

The feelings of Respiration, and those of Heat and of Cold, illustrate in a marked manner the fundamental doctrine of Relativity, or of change as a condition of consciousness. There is no feeling of respiration, unless by increase or diminution of the action of the lungs; and if we lived in an even temperature, heat and cold would be alike unknown. The induction of the principle of Relativity as regards these states is complete.

Sensations of the Alimentary Canal.

16. Digestion offers all the conditions of a sense. There is an external object—the Food; a distinct organ of sense—the Alimentary Canal and its appendages; and a set of Feelings arising from the contact, also distinct and specific. To treat these feelings under Taste, is to confound together two senses totally different in their character, although happening to have one common object or stimulant.

The *objects* of this sense are the materials taken into the body as food and drink. These materials are extremely various, but there is no corresponding variety in their action on the stomach. They can be reduced to a few general heads, according to their composition, it being found possible to assign a few leading substances that comprehend all the different sorts of material serviceable in nourishing the body. The following is an abstract of this classification:—

1st. *Water* and the watery liquids, including substances conveyed in solution, or suspension, in water.

2nd. *Saccharine* substances derived from the vegetable kingdom. This comprehends sugars, starch, gums, vinegar.

3rd. *Oily* substances. These include the various fats and oils, as well as alcohol. Like the former group, they are composed of carbon and the elements of water, but in them the carbon is in a much higher proportion.

4th. *Albuminous* substances, containing nitrogen: fibrine, gelatine, albumen, caseine (matter of cheese), vegetable gluten, 'all the materials which make up this group are derived generally from the animal kingdom, with the exception of the last, which is contained in great abundance in wheat; similar if not identical principles exist in other vegetables. Wheat, indeed, consists of two substances—one referable to the saccharine group, the other to the albuminous, the former consisting of starch, the latter of gluten.'

Milk is found to contain matter of all the four classes: water, sugar, oily matters (butter), caseine.

The three first classes are incapable of nourishing the principal animal tissues, such as nerve, muscle, &c. They are fitted rather for supplying fat, bile, and matters used in the production of the carbonic acid that escapes from the lungs. They are chiefly destined for the creation of animal heat, which in the main seems to arise from the conversion of carbon into carbonic acid. The fourth class, or the albuminous substances, are the proper elements of nourishment, having a composition fitting them for that purpose.—TODD and BOWMAN, II. 152, 3.

The differences that exist among the infinity of articles used as food are not at bottom so great as they seem. If we take the different species of grain,—wheat, barley, rye, oats, rice, maize, millet, we shall find they are all composed of the same ultimate materials, gluten and starch, though not in the same proportions. In like manner the potato is a starchy vegetable, with a very small share of gluten, hence the defective character of it as an article of nourishment. Another difference among vegetables relates to their texture, as fitting them for being acted on during mastication and digestion,—a circumstance, however, which cooking can modify. Thus the potato is a much looser texture than grain. A third point of distinction among alimentary substances, is the extraneous essences that may enter into them, and affect the sense of taste, and the general relish, as in the difference between mutton and beef, chicken and venison, brandy and rum. Such elements belong more to Taste than to Digestion, although this last function may be influenced by extraneous additions, as mustard and spices.

17. I extract from Quain's *Anatomy* the following general view of the *Organs of Digestion.*

'The *digestive apparatus* includes that portion of the organs of assimilation, within which the food is received and partially converted into chyle, and from which, after the chyle has been absorbed, the residue or excrement is expelled. It consists of a main or primary part named the *alimentary canal*, and of certain accessory organs.

'The alimentary canal is a long membranous tube, commencing at the mouth and terminating at the anus, composed of certain tunics or coats, and lined by a continuous mucous membrane from one end to the other. Its average length is about thirty feet, being about five or six times the length of the body. The upper part of it is placed beneath the base of the skull, the succeeding portion is situated within the thorax, and the remainder is contained within the cavity of the abdomen. In these several situations, its form, dimensions, and connexions, its structure and functions, are so modified that certain natural divisions of it, bearing different names, have been recognised by anatomists.

'It may be considered as composed of two parts: one situated above the diaphragm, and the other below that muscular partition, and therefore within the abdomen. The first division consists of the organs of mastication, insalivation, and deglutition; and comprises the *mouth*, the pharynx, and the *œsophagus*, or gullet. The second division consists of the organs of digestion, properly so called, and of those of defæcation; viz., the *stomach*, the *small intestine* and the *great intestine*.

'The accessory parts are chiefly glandular organs, which pour their secretions into it at different points. They consist of the *salivary glands* (named the *parotid*, *submaxillary*, and *sublingual*), the *liver*, and the *pancreas*. Besides these large glandular organs, a multitude of small glands, compound, follicular, or tubular, are collected together at certain points, or scattered over large portions of the inner surface of the alimentary canal: these are described along with the mucous membrane of each part. The remaining accessory organs are the *teeth*, the *jaws*, the *tongue*, and the *spleen*.'—Vol. III. p. 85.

18. The physiology of digestion must be very briefly stated here. The first stage is mastication, which serves the double purpose of breaking down the food and mixing it with saliva; the function of the saliva is now known to be to convert the starch into grape sugar, by a process of the nature of fermentation. The effort of mastication is purely voluntary; but when the food gets upon the back part of the tongue, it is passed into the bag of the pharynx, and propelled down the gullet into the stomach by involuntary muscular contractions. In the stomach it is exposed to the action of the gastric juice. This peculiar action is not as yet fully understood, but so far as the researches of physiologists have yet gone, the most reasonable conclusion is, that 'in man and the carnivora the fluid secreted by the stomach during digestion simply dissolves animal and vegetable substances of the azotized kind, so as to render them capable of absorption, without materially altering their chemical constitution, leaving starchy, oily, saccharine, and the allied substances but little or not at all acted on.' The matter that leaves the stomach to pass into the intestines, is known by the name of *chyme*. This is very soon mixed up with two other secretions, the pancreatic juice and the bile from the liver. In the stomach and along the intestine, there is an absorption going on, by two different ways. The one is by the lacteal vessels: these have the exclusive power of taking up the fatty matters, which constitutes the chief part of the *chyle*, as their contents are named. The other is by the capillary blood vessels, by whose means the nutritive matter is taken at once into the circulation, but before reaching the

heart it passes through the liver. The use of the pancreatic juice, which is poured into the intestine near its commencement, is to co-operate with the salivary glands in dealing with the starchy constituents of the food, and to contribute probably along with other fluids to the digestion of the fat. The functions of the liver are more complex and obscure. The bile appears to aid in the digestion of the alimentary matters; mixing with the fatty matters of the food, it is indispensable to their being absorbed in the intestines. The liver is further believed to form sugar and fat out of other elements passing into it by the circulation. The blood from the intestines, before returning to the heart, passes through the liver, and takes up the sugar formed independently there. In coursing through the intestine by the successive contractions of the tube, the material is lessened by absorption into the lacteals and blood vessels; at the same time it gathers new matter by secretion from the coats of the intestines, which matter is of the impure kind, and is destined to pass out of the system along with the husk and undigested remainder of the food. The extremity of the great intestine is called the rectum, and on it are brought to bear the muscles of final expulsion.

It is important to be remarked, before passing to the consideration of the states of consciousness allied with digestion, that only the upper and lower ends of the alimentary canal are supplied with cerebro-spinal nerves. The vagus nerve is largely distributed to the stomach, and nerves from the same system to the rectum, but the intestine receives its supply from the sympathetic system. This corresponds with our experience of alimentary sensations, which are concentrated chiefly in the two extremities of the canal, while the intervening thirty feet of intestine is almost entirely without sensation in ordinary circumstances. The movements of the intestine are kept up by means of the sympathetic system of nerves.

19. And now with regard to the Feelings of Alimentary action. These are of the pleasurable kind when the action is

healthy; disease and disorder bring on a countless multitude of pains.

Discussing first the sensation of taking food, we shall find a pretty general agreement as to its character. I do not speak of the feeling of Taste, but of the sensibility connected more particularly with the stomach, and which extends even to the mouth in connection with salivation, and is spoken of as the *relish*. If we include the entire mass of sensation arising from a healthy meal, and lasting a certain time after the meal is finished, at which stage the operation of digestion in the stomach is the sole cause of what we feel, we may safely pronounce it to be an agreeable state of a high order. It has in a high degree the characteristic of massiveness, or amount, being a rich, luxuriant, satisfying sensation. Such is the character common to all kinds of healthy nourishment; but there is the greatest possible difference in the qualities of food as regards stomachic relish; from turtle to stale oat-cakes, or a piece of black bread, what a mighty interval! We cannot pretend to assign the difference of digestive action that corresponds to such unequal degrees of sensation. To the richer kinds of food belong a feeling intense as well as voluminous. The magnitude of the sensation is attested by its power to submerge a great many irritations, and make itself for the time the ruling element of the consciousness. This power brings it into comparison with such feelings as healthy exercise and repose, nervous elation, and the intoxication of warmth.

The energy of Volition generated corresponds to the relish and to the stage of the operation. At first the stimulus to action is intense and even furious. Appetite is only inflamed by partial gratification; and until such time as the stage of fulness draws near, the pleasure only shows itself in supplying impulse to continue it. Eating is among the most characteristic examples of the general law of Feeling-prompted Action that we can produce, being not only for the avoidance of pain, but also for the glutting of a pleasurable sensation.

To complete the delineation of this mode of consciousness, we may notice the peculiarity of it as related to the Intellect. In doing this, however, we have only to repeat what has been said on most of the feelings hitherto discussed, that there is comparatively little permanence in idea when the state of the organs is such as to forbid the reality. But to this statement we must add the remark, that the reality is one that can never be long absent. As a general rule, it is true of digestive and all other organic sensations, that they are exceedingly powerful when present, and exceedingly little realized when absent. They are very unlike sights and sounds, loves and hatreds, and other states that the intellect can retain in the ideal form ; to imagine with effect the relish of a feast when under nausea, passes the power of the most vigorous mind.

The sensation connected with the lower extremity of the canal is chiefly of the nature of a feeling of relief from pain.

20. Another important healthy sensation of the alimentary canal is *Hunger*, the state preceding in order the one just de-described.

The physical concomitants of hunger are a collapsed condition of the stomach, and a deficiency of nutritive material in the system. The sensitive nerves distributed to the mucous surface of the stomach are first affected, then the nerves of the lower intestines, and finally an influence of the system generally adds to the pain and the feeling of depression. It is considered probable that the state of the muscular fibres of the stomach makes a part of the case.—(WEBER.) These are at first loose and uncontracted, but at a later stage their characteristic (peristaltic) movements are commenced upon the empty tube. The cutting of the nervus vagus (supplying the mucous surface) does not entirely abolish the feeling of hunger. The feeling itself is of the uneasy or painful class, with a degree of massiveness and engrossment corresponding to stomachic feelings in general.

The appetite for eating commences with a pleasant feeling, and consists of certain indefinite sensations in the region of the stomach, accompanied by stimulation of the muscles of chewing, and by the secretion of saliva. This passes next into an uneasy feeling; there come on oppressive gnawing pains, which are referred to the region of the stomach; these are followed by sensations of a still stronger kind derived from a more general action, under which the local feelings are submerged. This last is the state of inanition, or starvation.

Animals are driven in search of food after the nervus vagus is cut; which would seem to imply that the sense of starvation in the body generally is a part of the motive power of hunger. On the other hand it is contended, that when the digestion is diseased, the appetite for food is entirely wanting, however much the frame be suffering from want. The influence of the nerves and the nerve-centres is shown in the fact, that a desire of eating may exist when the stomach is full. In ordinary circumstances, the state of fulness of the stomach is followed by the sensation of Satiety. The physical link here is supposed to be the pressure of the stomach on the surrounding parts,—the coverings of the abdomen, &c.

21. The feeling of *Nausea* and *Disgust* is an effect indicating some great disturbance in the usual course of digestive operations. This state is associated with the act of vomiting, an act that may take place, '1. from the introduction of certain substances into the stomach, some of which, as bile, mustard, common salt, not becoming absorbed, must act simply by the impression they make on the mucous membrane; 2. By the introduction of emetics, as Tartar emetic, into the blood, or by the presence of certain morbid poisons in the fluid; 3. By mental emotion, as that excited by the sight of a disgusting object; 4. By irritation at the base of the brain.'—TODD and BOWMAN, ii. p. 214. To these must be added sea-sickness. Inflammation of the brain in children usually shows itself first in violent vomiting. The act of vomiting is the result of a reflex stimulus, directed towards the muscles that compress the abdomen in the act of expiration of the breath. These muscles violently contracting, while the exit of the air from the lungs is shut up, squeeze the

contents of the stomach upwards towards the mouth. The sensation of vomiting is in most cases horrible in the extreme. It proves by a strong instance the power of stomachic influences on the nervous system. The sensation is one *sui generis*—no other feeling can at all compare with it. There are many forms of unendurable pain, but this has a virulence of its own, great both in quantity and in intensity.

The sensations of nausea are also accompanied by irregular movements of the muscles of the pharynx. These are the seat of the characteristic feeling of nausea. Possibly in the stomach also, the sensation may be connected with irregular actions in the muscular fibres.

The feelings of nausea and disgust, and the objects causing them, are expressed in our language by a variety of strong terms. The 'disagreeable' is originally what revolts the stomach, extended in its application to other forms of the unpleasing. 'Disgust' is the extreme opposite of relish. The fact that these words are among the strongest that the language affords to express dislike or aversion, proves how deep and intense is the feeling that they primarily refer to.

Besides the objects that produce disgust by actual contact with the alimentary canal, there are substances whose appearance to the eye is disgusting. Certain gases also affect the smell in the same way. Disgusting sights are mostly the result of association; but some nauseous smells act from the very beginning. The arrangements of human life, particularly address themselves to our protection against disgusts; and singularly enough, the chief things to be avoided are the products of living bodies themselves. This is the foremost aim of the operations of cleansing and the removal of refuse. The influences that stimulate a healthy digestion and relish are contrasted with their opposites by the term 'fresh,' which we spoke of already as a quality of respiration, but which has still more emphasis as opposed to the causes of disgust. The power of resisting nauseating influences is an indication of great stomachic vigour in the right direction.

There are many things entering into the *ugly*, or opposed to the beautiful; but nothing contrasts with beauty so entirely, or annihilates it so effectually, as a disgust.

22. The foregoing cases are intended to include the most prominent of our habitual and ordinary experiences in relation to the alimentary processes. With regard to the feelings arising from disease in the various organs of digestion, these are so many forms and varieties of pain. If we were to go systematically through the entire series of organs enumerated above, we should have to commence with mastication, and describe the pains and agonies which the *teeth* render familiar to us. Distemper of the salivary glands yields a sensibility, not of the acute kind, but annoying, and difficult to bear, like disordered secretions in general. The pains and disorders of the early stages of digestion, that is in the stomach, where the sensitiveness is greatest, are very numerous, and are sometimes acute, but oftener not so. In proportion to the genial influence of a healthy digestion upon the general mass of sensibility, is the malign influence of an unhealthy digestive action. It is in extreme cases altogether overpowering, and renders futile almost every attempt to establish a pleasurable tone by other causes. The nervous connexion between the brain and the stomach is intimate and powerful; and shows itself in many ways. Not only is there a keen sensibility to stomachic states, but also a strong *returning* influence from the brain upon the digestive secretions in the way of supplementing their force, or aiding them by a stimulus from without.* This partial dependence of stomachic vigour upon a derived power from the cerebral mass, is well attested by the tendency of an overworked brain to bring on disordered digestion. On the whole, however, we must make allowance for differences of temperament. The stomachic sensibility will be found very unequal in different individuals, just as

* Wagner states (*Elements of Physiology*, § 362), that 'Increased movements of the intestines have been observed when the corpora quadrigemina have been irritated.'

we find inequalities in the feeling of music, or any other sense. Some persons count the feelings of digestion a very small item among the sources of pleasurable excitement; but I am led to suppose, from the prevailing attention to the choice and preparation of food, that, for the great majority of people, I have not overstated their importance.

On acute stomachic pains, it is not necessary to spend much discussion. They have their character chiefly from the great sensibility of the alimentary surface, which often makes a slight cause of irritation peculiarly keen and intolerable. On the subject of pains and distempers not acute, but connected with want of tone and vigour in the digestive system, or with deranged mucous surface, the pathologist and physician have much to describe. The stomach, intestines, liver, &c., have each their various modes of distemper. But what chiefly interests us is to mark, as a specific mental experience arising out of many forms of alimentary derangement, the depression and ennui spread over the consciousness, at the times when any of these organs are failing to perform their part. This effect is one that, if not intense or acute, is powerful in its amount, and extremely difficult to combat, either by other stimulants, or by the action of the mind recalling or imagining situations of a less gloomy cast. It either resembles or else produces that physical depression of the nervous substance already considered; the likeness holds remarkably in the leading features, as in the distaste for existence while the state lasts, and in the extreme facility of forgetting it when it is gone. In the rational point of view, hardly any sacrifice is too much to prevent the frequent recurrence of this state, but so little hold does it take as a permanent impression, that the reason has very little power in the matter. Any feeling of general depression is easily forgotten when the animal spirits are restored; the evil then seems to have neither a local habitation nor a name.

We have now described the principal states of feeling that enter into the general conditions called physical Comfort and Discomfort. The most powerful constituent elements of these two opposite modes of existence, are the feelings of the muscular system as regards exercise, and the various classes of organic sensations above enumerated.

Feelings of Electrical States.

23. We shall touch upon only one other class of feelings before passing from this subject, the feelings of Electric and Magnetic agencies. It is very difficult to say anything precise on this class of sensations, but their interest is such that we ought not to pass them unnoticed.

The *electric* shock from a Leyden jar is perhaps the simplest of all the electric effects; yet we are not able to describe the change that it produces on the tissues affected by it. When very severe, it destroys life. The stroke of lightning is proved to be of the same nature. The peculiar feeling of this kind of electricity has its main character from the suddenness of the action; the painful effect is described as a shock or a blow. When pretty smart, it leaves an unpleasant impression behind, such as to render us averse to a repetition of the experiment. There can be no doubt of the disorganising tendency of the influence when at all severe; and the impression is one that remains with us as a thing of dread, like a scald or the blow of a weapon. The *Voltaic* shock is very different, in consequence of the altered character of the discharge; an incessant current is substituted for an instantaneous shock. Still the painful character remains. The first contact causes a slight blow like the other; then succeeds a feeling of heat, and a creeping sensation of the flesh as if it were unnaturally wrenched or torn, which after a time becomes intolerable. The peculiar distorting sensation is carried to the utmost in Faraday's *Magneto-Electric Machine*, where the current, instead of continuing of one character, is changed from negative to positive, and from positive to negative, a great many times every second. The sense of contortion from this machine may be described as agonising. Feebler discharges of this kind are employed as an electric stimulus in certain diseases. There seems to be a power in electricity to revive the action of torpid nerves; and after experience both of common and of voltaic electricity, for the purpose, Faraday's invention has been adopted in preference to either.

24. The electricity of the Atmosphere is believed to be the cause of quite other sensations than the shock of the thunderbolt. In some states, this influence is supposed to kindle a genial glow in the human frame, while in other states, the effect is painful and depressing. Many persons complain of a disturbed, irritated condition of body on the eve of a thunder-storm. The highly electrified state of the atmosphere in dry cold is generally considered as bracing; while part of the depression of moist sultry weather is attributed to the absence of electricity.* Much, however, remains to be proved in regard to these popular beliefs. The time of greatest influence on the human sensibility from this class of influences is the eve of an earthquake or volcanic eruption; in which case it is known that the earth's magnetism suffers violent disturbances. On these occasions, feelings of depression amounting to nausea and sickness overtake both men and animals, as if some great stimulus of a supporting kind were suddenly withdrawn.

25. The influence of magnetism has been applied to produce new and artificial sensations in such experiments as those of Baron Reichenbach; but as the same sensations have been caused by crystals, heat, light, chemical activity, and the living hand, they can hardly be assigned specifically to the magnetic action. Reichenbach records two different classes of feelings arising in his patients, according to the polar direction of the agent, the one cool, refreshing, delightful; the other in all respects the opposite.†

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* I am informed, as the result of the observations at Kew Observatory (adopted at the instance of the British Association, for observing atmospheric electrical states), that the electricity of the air is usually in proportion to the degree of cold.

† I may remark, however, that although Reichenbach's experiments have been performed with an amount of care unknown before in this class of sub-

SENSE OF TASTE.

This is a peculiar sense attached to the entrance of the alimentary canal, as an additional help in discriminating what is proper to be taken as food, and an additional source of enjoyment in connexion with the first reception of the nutritive material.

1. The substances used as food are more completely distinguished by the taste than by the digestion. The tastes of bodies are almost as widely different as is their chemical composition; but in order to have a taste, a substance must be either liquid or soluble in the mouth.

The bodies acting on the sense of Taste are innumerable. They are found in the mineral, vegetable, and animal kingdoms, and many of them may be discriminated by means of this property.

Of mineral bodies, water and the elements of atmospheric air are remarkable for having no taste. But most other liquids and gases, and a very great proportion of solid substances, if capable of being dissolved by the saliva, have a distinct action on the palate. All acids, all alkalies, and nearly all soluble salts are sapid.

It is remarked that in salts the taste is determined more by the base than by the acid. Thus salts of iron have in general the inky taste; salts of magnesia partake more or less of the well known character of Epsom salts. There is also something of a common character in the salts of silver, of soda, of potash, of ammonia.

It is a curious fact, that the chemical combination $M^2 O^3$, or two atoms of a metal with three of oxygen (termed also sesquioxides) causes sweetness. Alumina is an illustration;

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jects, and rivalling the most approved scientific researches, yet it is still a doubt with many whether these effects be not due to imagination. Mr. Braid's admirable observations on the influence of ideas in producing bodily states, show to what great lengths the power of imagination may go in a peculiar class of temperaments.—(See his criticism on Reichenbach, and writings generally.)

for alum is known to be sweet as well as astringent. The oxide of chromium is still sweeter. Glucina is the sweetest of all, and has its name from this quality.

The salt of silver, termed hypo-sulphite, and its combinations with hypo-sulphites of the alkalies, are the sweetest bodies known.

The salts of lime are bitter.

The organic alkalies are all intensely bitter; quinine, morphine, strychnine, are instances. The taste of strychnine is apparent when diluted with water, to the degree of one in a million.

There is a certain class of vegetable compounds, neutral bodies, which are at present characterised as the bitter and extractive principles of plants. I quote a few examples from the list given in GREGORY'S *Organic Chemistry*, p. 457.

Gentianine, from *Gentiana lutea*, forms yellow needles, very bitter. *Absinthine*, from *Artemisia absintheum*, or wormwood, is a semi-crystalline mass, very bitter, soluble in alcohol. *Tanacetine*, from *tanacetum vulgare*, is very similar to it. *Syringine* is the bitter principle of the lilac, *syringa vulgaris*. *Colocinthine*, the active principle of colocynth, is amorphous, intensely bitter and purgative.

Quassine is a yellow, crystalline, and very bitter substance, from the wood of *quassia amara*. *Lupuline* is the bitter principle of hops. *Liminine*, or *Limine*, is a bitter crystalline matter, found in the seeds of oranges, lemons, &c.

With regard to vegetable and animal substances in general, I quote the following paragraph from Gmelin. 'Some organic compounds, as gum, starch, woody fibre, white of egg, &c., have no *Taste;* others have a sour taste (most acids); or a rough taste (tannin); or sweet (sugar, glycerin, glycocol); or bitter (bitter principles, narcotic substances, and many acrid substances, also many resins); or acrid (acrid oils and camphors, acrid resins, acrid alkaloids); or fiery (alcoholic liquids, volatile oils, camphors).'*

* GMELIN'S *Chemistry*, vol. vii. p. 66.

Not only are the different classes of vegetable and animal products distinguished by their taste, as apples from apricots, wine from cider, flesh from fat, but in every such class there are many distinguishable varieties. The class of wines based on the common ingredient, alcohol, spreads out into innumerable kinds from the presence of sapid substances in quantity so small as to elude the search of the chemist. It is shown by this and by many other facts, that an extremely minute portion of a sapid substance may make itself acutely felt to the taste. The bitter element of soot, for example, can be distinguished in cookery to a very high degree of dilution.

2. The *organ* of Taste is the tongue, and the seat of sensibility is the mucous membrane covering its surface.

'The upper surface of the tongue is covered all over with numerous projections, or eminences, named *papillæ.* They are found also upon the tip and free borders, where however they gradually become smaller, and disappear towards its under surface.' These papillæ are distinguished into three orders, varying both in size and form.

'The *large* papillæ, eight to fifteen in number, are found on the back part of the tongue, arranged in two rows, which run obliquely backwards and inwards, and meet towards the foramen cæcum, like the arms of the letter V.' 'The *middle-sized* papillæ, more numerous than the last, are little rounded eminences scattered over the middle and fore part of the dorsum of the tongue; but they are found in greater numbers and closer together, near and upon the apex.' 'The *smallest* papillæ are the most numerous of all. They are minute, conical, tapering, or cylindrical processes, which are densely packed over the greater part of the dorsum of the tongue, towards the base of which they gradually disappear. They are arranged in lines, which correspond at first with the oblique direction of the two ridges of the large papillæ, but gradually become transverse towards the tip of the tongue.'

'These different kinds of papillæ are highly vascular and sensitive prolongations of the mucous membrane of the tongue. When injected, they seem to consist almost entirely of capillary vessels; the large papillæ, containing many vascular loops, whilst the smallest papillæ are penetrated by only a single loop. Nerves proceed in abundance to those parts of the tongue which are covered with papillæ, into which the nerve-tubes penetrate.' 'The papillæ are undoubtedly the parts chiefly concerned in the special sense of taste; but they also possess, in a very acute degree, common tactile sensibility.'—QUAIN, Vol. III., pp. 122—4.

The nerves supplied to the tongue are the glosso-pharyngeal on the back part, and twigs of the fifth pair on the fore part. The former must be considered as in all probability the nerve of taste proper. The fifth pair, being a nerve of touch, can confer that high tactile sensibility distinguishing the tip of the tongue; but there are no facts decisively showing any portion of this nerve to be the medium of pure taste. It is true that some so-called tastes, as the sour or acid, can be discerned by the tip, but these are properly of the nature of pungent or fiery stimulation, capable of acting on nerves of touch. A *bitter* taste, which appeals to the strict gustatory sensibility is felt principally in the back part of the tongue. Fiery, cooling, and astringent tastes may arise through the lips and the gums, showing that they are merely effects on our common or tactile sensibility. Mustard acts on any tactile surface with variations of degree merely. It has not been possible to excite a pure gustatory sensation by irritating the fifth pair of nerves.

3. With regard to the precise localities of the tongue where the sensibility resides, there has been some difference of opinion. 'We conclude generally,' say Messrs. Todd and Bowman, 'with regard to the tongue, that the whole dorsal, or upper, surface possesses taste, but especially the circumferential parts—viz., the base, sides, and apex. These latter regions are most favourably situated for testing the sapid qualities of the food; while they are much less exposed than the central part to the pressure and friction occasioned by the muscles of the tongue during mastication. The central region, as a whole, is more strongly protected by its dense

epithelium, and is rougher, to aid in the comminution and dispersion of the food.' But in addition to the tongue, 'the soft palate and its arches, with the surface of the tonsils, appear to be endowed with taste in various degrees in different individuals.'—I., 443.

The increasing sensibility of the tongue, from tip to back, serves as an inducement to move the foot gradually onward in the direction of the pharynx, in order to be finely swallowed. The same sensibility, acting according to the general law of feeling-guided action, or volition, keeps up the mastication, whereby the sapid action of the food is increased by solution and comminution of parts. Thus it is that mastication is purely a voluntary act, while deglutition or swallowing is purely reflex and involuntary.

Among the conditions of taste, in addition to solubility, it is noticed that 'taste, like touch, is much influenced by the extent of surface acted on; and is also heightened by the motion and moderate pressure of the substance on the gustatory membrane.' In order to taste, also, the tongue must not be in a dry or a parched condition. 'The impression of cold air deadens the sense of taste.'*

4. The precise mode of action, whereby the nerves of the tongue are stimulated, has not as yet been explained. Taste

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* Another condition of taste, brought to light by the researches of Graham on 'Dialysis,' is that the substance should belong to the 'crystalloid' class of bodies, and not to the 'colloid' class. The colloids are represented by starch, the gums, caramel, tannin, albumen, gelatine, vegetable and animal extractive matters. Now it is a law that these colloids do not penetrate one another, except with slowness and difficulty; whereas a crystalloid body like sugar or salt penetrates a colloid very readily. Animal membranes belong to the colloid class, and accordingly while they are freely permeated by crystalloid substances, they resist the passage of starch, gum, albumen, gelatine, &c. This would be a sufficient reason for the absence of taste in these bodies. Graham remarks:—'While soluble crystalloids are always highly sapid, soluble colloids are singularly insipid. It may be questioned whether a colloid, when tasted, ever reaches the sentient extremities of the nerves of the palate, as the latter are probably protected by a colloidal membrane impermeable to soluble substances of the same physical constitu-

may be produced by mechanical irritation of the surface, as by a smart tap with the fingers on the tip of the tongue, and by galvanism. Looking at the substances that cause tastes, it appears probable, that their chemical constitution is the determining circumstance, whence it would seem that the action is a chemical one. A certain secretion from the blood vessels that line the papillæ of the tongue combines with the dissolved food, and the act of combination constitutes the stimulus of the nerve fibres. We know that a chemical action on any surface or tissue will suffice to stimulate a nerve and produce sensation; and it is difficult to assign any other mode of stimulus either in taste or in smell.

5. Having thus considered the external objects of the sense, and the structure of the organ, it remains for us to proceed to the mental phenomena, that is the Sensations themselves. At the outset we are met with a complexity, which hardly belongs to any other sense. From what has been already said, the reader will gather, if he has not otherwise remarked it, that the tongue is the seat of a twofold sensibility, taste and touch. I am disposed to go still further, and to ascribe to it a threefold sensibility, viz.—touch, taste properly and strictly so called, and *relish*, or a participation in the alimentary sensations; my reasons are such as the following. First, there is an obvious continuity of structure in the tongue and alimentary canal, a common character of surface as regards mucous membrane, glands, and papillæ, which would imply some community of action and feeling, in the midst of diversity. 'We may here allude to a certain gradation that is apparent from the papillæ of touch, through those of taste, to the absorbing villi of the small intestines. Touch shades into taste, and at a lower point sensibility is lost.'—(Todd and Bowman, I. 441.) Second, the tongue, besides its power of discriminating niceties of taste that have very little reference to digestibility, has the power of telling at once whether a substance will agree or disagree with the stomach, and this it can do only by being as it were a part of the stomach, affected like it by wholesome or unwholesome

contacts. Third, the peculiarity we call relish is not the same as a mere taste. For the type of taste, I may take such substancee as common salt, quinine, soot, Epsom salts; for relishes, I would select butter and animal flesh; the savoury in cookery being made up much more of relishes than of tastes. The condition of the stomach governs the one but not the other. After an attack of sea-sickness, a person is still in a condition to discriminate sour, bitter, alkaline, or acrid, when the choicest food has no feeling in the mouth. Fresh, disgusting, nauseous, are terms applying to the stomachic sensibility and to that portion of the tongue in sympathy with the stomach, and not to tastes as I understand them. With this explanation, I shall now proceed to examine in detail the sensations of the tongue.

6. Deferring for the present the consideration of the tactile sensibility, shared by the tongue in common with the skin and the inner surface of the mouth, we shall have to classify and describe the several kinds of sensations coming under both taste and relish. Following out our general plan of taking the least intellectual sensations first, we should commence with the relishes and disgusts of taste, which constitute its relation with the alimentary sensations already treated of. But these feelings need not be again gone into in the detail; all that appears necessary is to quote a few instances, with the view of illustrating still farther the distinctions we have drawn, between the alimentary sensations of the stomach and those of the mouth, and between both and the proper sensations of taste.

7. The classification will therefore commence with *relishes.* These are the agreeable feelings arising from the stimulus of food on the organs of mastication and deglutition; they are intense in degree. The substances that produce them in greatest amount are reckoned savoury by pre-eminence. Animal food has the highest power of exciting a vigorous relish, or that keen sensation so powerful as a stimulus to mastication and the taking of food, rendering the individual voracious for the time being. A healthy digestion and the

state of hunger are the necessary conditions of a strong relish, whether in the stomach or in the mouth, from which fact, as already said, we can discern the difference there is between a mere taste and a relish. Butter and oils and fatty substances are relishes, used for that purpose along with the more tasteless kinds of food, such as bread. Sugar I take to be both a taste and a relish. Being one of the necessaries of animal life, as is proved by the function of the saliva in producing it from starchy substances, there is a direct craving for it throughout the system, and everything craved for in this way is likely to produce a far deeper impression than a mere sensation of taste.

The relish in the mouth is much more intense or acute than the feeling in the stomach, although this last may be more influential upon the general tone of the system by its amount. That the two interests are not altogether identical is shown by the circumstance that many tongue relishes are hard of digestion. But I am not aware of any case where what passes in the mouth is found nauseous to the digestion; on this point the two parts would seem to be in accord.

8. Relishes imply their opposite, *disgusts*. This sensation is constantly inspired by certain substances in consequence of their own nature; at particular times it may arise from any contact whatever, the alimentary surface being in a state of distemper. Oily substances seem to have a facility in causing disgust, from what cause I cannot say, seeing that they class also among relishes. Their mechanical form, when in the liquid or half liquid state, would appear to have an unfavourable action: we are more ready to revolt at melted butter than at solid. Repletion renders any kind of food distasteful, and some kinds absolutely nauseous. In every point of view, this feeling is as much dependent on the condition of the alimentary canal as on the material tasted.

The different degrees of relish and nausea exhaust all that part of taste in sympathy with digestion; what follows, next in order, belongs to the distinctive sensibility of the tongue.

9. *Sweet* tastes. At the head of these, we must class the sugary taste, as being the most prevalent of all forms of sweetness. The sweetness of every kind of fruit, of bread, and of milk, of alcoholic liquors, and of confectionery in general is known to arise from sugar. Besides the relish that I attribute to this article of food, it undoubtedly acts upon the sense of taste in a remarkable way. We derive from it a highly pleasureable sensation in this limited sense; but no pleasure of mere taste can be compared in amount and influence to an agreeable alimentary feeling. We can lay it down as a rule, that the pleasures of taste proper have as a whole a less influential action than the other class, and this must serve as a defining circumstance of every individual of them. The feeling of a sweet taste is acute and is dwelt upon with much satisfaction, but does not inspire the energy of the feeding action that follows up a savoury morsel. When digestion is satisfied, there remains the enjoyment of sweets, and when the taste for these becomes cloyed by repetition, it is by an independent effect on the gustatory nerves.

But the great distinction of this feeling, and of all other feelings of taste proper, relates to the intelligence, or to the power of discrimination belonging to this organ, whereby a boundless number of substances can produce impressions recognised by us as totally different in character, which impressions of difference can remain or be recalled, after the original is gone, to compare with new cases that may arise, and to give that sense of agreement or disagreement whereon all our knowledge of the world is based. In the case of sweetness, for example, not only can we be affected with the pleasurable feeling or emotion belonging to it, but we can be distinctively affected by a great many substances possessing the quality; we can identify some and feel a want of identity in others; and we can so far retain the impression of a taste of yesterday as to compare it with a taste of to-day. This feature distinguishes the feelings of the mouth from organic feelings; it distinguishes in some degree tastes from relishes, although these last also possess considerable range of discrimination; and it is the point of superiority which sight, hearing, and touch, have to a still greater degree over organic sensations.

10. *Bitter* tastes. These are exemplified by quinine, gentian, or bitter aloes. This, and not sourness, is the proper contrast of sweet. Sweetness is the pleasure proper to taste, bitterness the peculiar or distinctive form of pain inflicted through this sense. Without having the bulk and influence of the massive forms of pain, this sensation is highly intense in its own limited region, and sets on a wryness and contortion of the features, showing how repulsive and distasteful it is. A man may, however, have a great deal that is sound and pleasant about him, notwithstanding a bitter taste in his mouth, and he may therefore be induced, for good reasons, to tolerate it. This does not mar the happiness in the manner of many of the feelings above discussed. Still it is sufficient to create acts of avoidance, and sentiments of aversion, leaving an impression behind it such as to keep up a self-protecting impulse in the future. The sweet and the bitter represent the two characteristic modes of acting on the pure gustatory nerves. They are distinct from relish on the one hand, which involves sympathies with the stomach, and from the modes of tactile sensibility on the other. The classes that remain involve in a greater or a less degree the nerves of touch.

11. *Saline* tastes. Common salt may be taken as an example of this class. Mineral waters, which contain salts of soda, magnesia, and lime, have a saline taste. This taste is rarely an agreeable one, in many cases it is very disagreeable, but we should be disposed to describe the feeling, in most instances, as singular and characteristic, rather than as either pleasing or the reverse.

The repulsive taste of Epsom salts would be termed a compound of the saline and the bitter.

12. The *alkaline* taste is usually more energetic than the saline, as might be expected, seeing that salt is a neutralized alkali. But if the remark above made be correct, namely,

that salts owe their taste principally to their base, the alkali ought to have a considerable share of the saline in taste. Most mineral alkalies and some earths and oxides of metals have characteristic tastes, rarely agreeable, and often not markedly the reverse.

13. The *sour* or *acid* taste is much more uniform in its nature than either the saline or the alkaline; which we may fairly ascribe to the influence of the acid quality itself, irrespective of the constituent elements. This is a sharp, penetrating, pungent action, having, when very powerful, more the pain of a burn, than of a repulsive taste; in diluted forms it is an agreeable pungent stimulus to the mouth; hence the liking for vinegar (the sour of cookery as sugar is the sweet), and for acid fruits and vegetables. A galvanic current in the mouth causes sourness.

14. The *astringent* is a distinct form of the sensation of taste; as an example, we may refer to the effect of alum in the mouth. It is evident, however, that in the acid action, and still more in this of astringency, we depart farther and farther from the proper feeling of taste. Astringent substances act on the skin and on the mucous membranes generally, and the influence lies in a kind of contraction or forcible shrinking of the part, to which we are sensitive whenever it occurs as a touch. The 'rough taste of tannin' may be put down under astringency.

15. The *fiery* taste of alcoholic liquors, camphors, and volatile oils, given in Gmelin's classification, seems to me to be happily designated. I am disposed to think that this too is more a tactile action than a gustative, although in some of the other substances entering with alcohol into wines, spirits, and malt liquors, there is a genuine stimulus of the taste. Gmelin's *acrid* taste may be looked on as a form of the fiery, or astringent, combined with some ingredient of the bitter. The pungency that marks all this class of sensations is a remarkable state of feeling deserving to be once for all discussed at length. This discussion, however, I prefer to take up under the sense of smell, the next in order in our arrangement.

16. With regard to the Intellectual aspect of Tastes in general, Longet observes that these sensations are deficient as regards the power of being remembered; and he gives, as a proof, the fact that, when we dream of being present at a repast, we see the viands but do not taste them. This is an extreme comparison; it contrasts the most intellectual of all the senses, the most abiding of all sensations, with those that are least so. It is so far true, that we do not recover sensations of taste so as to live habitually on the ideas of them, but they are slightly recoverable even as ideas, and, for the purposes of identification and contrast, they may be recovered to a very great extent. A wine tasted to-day can be pronounced the same, or not the same, as a wine tasted a week ago, while well marked tastes may be remembered for years in this way.

The intellectual character of the sense is also illustrated by its improvability. A wine-taster, a cook, or a chemist, can acquire a delicate sensibility to differences of taste, implying that its impressions can find an abiding place in the memory.

SENSE OF SMELL.

This sense is in close proximity to the organ of Taste, with which smell frequently co-operates; but we may consider the sense of smell as placed at the entrance of the lungs to test the purity of the air we breathe.

1. The *external objects* of Smell, the material substances whose contact produces the sensations, are very numerous. They require to be in the gaseous state, in the same way that the objects of taste require to be liquified. Solids and liquids, therefore, have no smell except by being evaporated or volatilized.

The greater number of gases and vapours are odorous. Of inodorous gases, the principal are the elements of the atmosphere, that is to say, nitrogen, oxygen, vapour of water or steam, and carbonic acid.* In the long list of gaseous

* With regard to carbonic acid, the assertion as to the absence of smell is true of the amount present in the atmosphere; but, collected in mass, this

bodies recognised by the chemist, we find very generally some action on the nostrils,—carbonic oxide, sulphurous acid, chlorine, iodine, the nitrous gases, ammonia, sulphuretted and phosphoretted hydrogen, &c., the vapour of muriatic, nitric, and other acids. The singular substance *ozone,* produced occasionally in the atmosphere, is named from its smell, which is the smell of sulphur, and of the odour given forth by electricity. Some of the metals and solid minerals give out an odour, as, for example, the garlic smell of arsenic, and the odour of a piece of quartz when broken. The effluvia of the vegetable kingdom are countless; besides such widely spread products as alcohol and the ethers, a vast number of plants have characteristic odours, usually attaching to their flowers. The animal kingdom also furnishes a variety of odours; some general, as the 'scent of blood,' and others special, as musk, the flavour of the cow, the sheep, the pig. 'All volatile organic compounds,' says Gmelin, 'are odoriferous, and most of them are distinguished by very strong odours; *e.g.* volatile acids, volatile oils, camphors or stearoptenes, and alcoholic liquids; marsh gas (carburetted hydrogen), and olefiant gas, have but very little odour.'

The pleasant odours, chemically considered, are hydro-carbons; that is, they are composed chiefly of hydrogen and carbon. Such are alcohol and the ethers, eau de Cologne, attar of roses, and the perfumes. Many smells, however, elude investigation from the minuteness of the substance causing them. Thus, the vinous flavour is due to a substance which the chemist has been able to separate, being termed the œnanthic ether, but the bouquet of individual wines has not been laid hold of.

The repulsive and disagreeable odours very frequently

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gas has a slightly pungent, somewhat acid odour. This is an important distinction observable in the case of both tastes and smells; some substances yield intense effects in quantities inconceivably minute, while other substances require to act in considerable masses before being sensible in any degree.

contain sulphur. Sulphuretted hydrogen is one of the most common of the disgusting class.

The worst smelling substances as yet discovered have arsenic for their base, as will be seen from the following extract. (GREGORY'S *Chemistry*, p. 382.)

'When acetate of potash is heated along with arsenious acid, a very remarkable liquid is obtained, which is the oxide of a new radical. This liquid, which is spontaneously inflammable, and has a most offensive alliaceous smell, has long been known in an impure state, under the names of liquor of Cadet, and *alcarsine*. Bunsen, by a long series of the most profound and persevering researches, established its true character as the oxide of the radical *kakodyle*.' This radical, when obtained, 'is a clear liquid, refracting light strongly. When cooled, it crystallizes in large square prisms, and acquires, when pure, the appearance of ice. Its smell is insupportably offensive, and its vapour is highly poisonous. The two latter characters belong to all the compounds of kakodyle, with hardly an exception, Protoxide of kakodyle, the chief ingredient in the liquor of Cadet, is most offensive to the smell, and very nauseous to the taste. 'Chloride of kakodyle is a volatile, horribly fetid liquid, the vapour of which attacks strongly the lining membrane of the nose, and provokes a flow of tears.'

The pungent odours have ammonia for their type. The volatile alkali, nicotine, the element of the snuffs, is an instance. In smelling salts, ammonia is the substance given forth.

Liebig has been able to lay hold of, and isolate, the substance that gives the odour of roast meat. Burning fat gives forth odours which exemplify the volatile oils specified by Gmelin.

2. The *development* or production of odours is favoured by a variety of circumstances. Heat, by its volatilizing power, and by promoting decomposition, is the most powerful agent. Light, also, which carries forward the development of the plant, is an odoriferous influence. Hence the abundance and

variety of odours in warm and sunny climates, and in the summer season. The presence of moisture is often favourable; but the manner of acting of this agency is not always obvious. It may perhaps dissolve solid matters, and so put them in the way of being volatilized; this may be the cause of the evolution of perfumes after a shower. On the other hand, some flowers are most odorous when dried. Friction is a source of odours; by rubbing two pieces of flint or siliceous rock a smell is given forth; sulphur treated in the same way has a smell. Many of the metals have the same property. Doubtless some ingredient is volatilized by the rubbing action.

3. The *diffusion* of odours is an interesting point, and has been cleared up by the researches of Professor Graham. Some odours are light, and therefore diffuse rapidly and rise high; as, for example, sulphuretted hydrogen. Such is evidently the character of the aromatic and spice odours; they, by their intensity and diffusibility combined, make themselves felt at great distances. The Spice Islands of the Indian Archipelago are recognised far out at sea. It happens, however, that the sweet odours are remarkably persistent, while the sulphuretted compounds, which are among the most nauseous, are very rapidly destroyed in the atmosphere.

The animal effluvia (excepting sulphuretted hydrogen) are dense gases, and are diffused slowly. They do not rise high in the air. In scenting, a pointer keeps his nose close to the ground. The unwholesome effluvia of the decaying matter laid on the soil is avoided by getting to a moderate height; odours will be smelt by a person lying that would not be felt standing, such is the difference between a stratum of eighteen inches and a height of five feet. The danger of lying on the ground in tropical swamps is a matter of fatal experience; swung in a tree fifty feet high, one may pass the night safely. Here diffusibility is one, although not the only circumstance; during the night, the ventilation or upward current from the ground is arrested, and the malaria, being little diffusible or buoyant, settles on the surface.

4. We have next to consider the *organ* of smell, that is,

the nose. 'This organ consists of, first, the anterior prominent part, composed of bone and cartilage, with muscles which slightly move the latter, and two orifices opening downwards; and secondly, of the two nasal fossæ, in which the olfactory nerves are expanded. The narrow cavities last mentioned are separated one from the other by a partition (the septum of the nose) formed of bone and cartilage; they communicate at the outer sides with hollows in the neighbouring bones, and they open backwards into the pharynx through the posterior nares,' or openings. The sensitive surface is a membrane lining the whole of the interior complicated cavities, called the *pituitary* or *Schneiderian* membrane. The tortuosity of the passages of the nose gives extent of surface to this membrane, and thereby increases the sensibility of the nose as a whole. I shall quote part of the anatomical description of this sensitive tissue. 'The cavities of the nose are lined by a mucous membrane of peculiar structure, which, like the membrane that lines the cavity of the tympanum, is almost inseparably united with the periostium and perichondrium, over which it lies. It belongs, therefore, to the class of fibromucous membranes, and it is highly vascular. Named the pituitary membrane, it is continuous with the skin, through the anterior openings of the nose; with the mucous membrane of the pharynx, through the posterior apertures of the nasal fossæ; with the conjunctiva (of the eye), through the nasal duct and lachrymal canals; and with the lining membrane of the several sinuses (hollows) which communicate with the nasal fossæ. The pituitary membrane, however, varies much in thickness, vascularity, and general appearance in these different parts.' With regard also to the distribution of the olfactory nerve on the membrane, there are great differences in the parts, the general fact being that the distribution is most copious in the interior parts of the cavity or those farthest removed from the outer openings. The parts near the openings are supplied with nerves from the fifth pair, which give to these parts a tactile sensibility, excited by pungent odours, and by cold.

The olfactory nerve is the most conspicuous of the nerves of sense; it passes inward to a special ganglion, called the olfactory ganglion, which is a prominent object of the brain in all the vertebrate animals, and in the lower orders stands forth as a distinct lobe, or division, of the encephalon.

5. The *action of odours* on the membrane of the nose has next to be considered. On this subject, as on the action of sapid substances on the tongue, much remains to be known. Nevertheless there are some interesting facts which show that the action is of a chemical nature, or at least depends upon chemical conditions. For the following statements I am indebted to Professor Graham.

Odorous substances in general are such as can be readily acted on by oxygen. For example, sulphuretted hydrogen, one of the most intense of odours, is rapidly decomposed in the air by the action of the oxygen of the atmosphere. In like manner, the hydro-carbons above alluded to as odorous, are all oxidizable,—the ethers, alcohol, and the essential oils that make the aromatic perfumes. The gases that have no smell are not acted on by oxygen at common temperatures. The marsh gas, carburretted hydrogen, is a remarkable case in point. This gas has no smell. As a proof of the absence of the oxidizable property, Professor Graham has obtained a quantity of the gas, from the deep mines where it had lain for Geological ages, and has found it actually mixed up with free oxygen, which would not have been possible if there had been the smallest tendency for the two to combine. Again, hydrogen has no smell, if obtained in the proper circumstances; now this gas, although combining with oxygen at a sufficiently high temperature, does not so combine at any temperature endurable by the human tissues.

It is farther determined, that unless a stream of air containing oxygen, pass into the cavities of the nostrils, along with the odoriferous effluvium, no smell is produced. Also, if a current of carbonic acid accompanies an odour, the effect is arrested.

In the third place, certain of the combinations of hydrogen have been actually shown to be decomposed in the act of producing smell. Thus, when a small quantity of seleniuretted hydrogen passes through the nose, the metallic selenium is found reduced upon the lining membrane of the cavities. The action on the sense is very strong, notwithstanding the minuteness of the doze; there is an intensely bad smell, as of decaying cabbage, and the irritation of the membrane causes catarrh.

These facts, so far as they go, prove that there is a chemical action at work in smell, and that this action consists in the combination of the oxygen of the air with the odorous substance.*

6. We pass now from the physical to the mental phenomena of smell; the *sensations*, or peculiar states of consciousness, that all those physical antecedents end in giving birth to. Unavoidable allusion has already been made to those mental effects in the description of the smelling substances.

'Linnæus has divided odours into seven principal classes: 1st. *aromatic*, as the carnation, the laurel, &c.; 2d. *fragrant*, as the lily, the crocus, the jasmine, &c.; 3rd. *ambrosiac*, among which are musk and amber; 4th. *alliaceous*, which are agreeable to some persons and disagreeable to others, and more or less of the character of garlic, assafœtida, for example, and several other gum-resinous juices; 5th. *fetid*, as those of the goat, of the rag-wort (*orchis hircina*), valerian, &c.; 6th. *virulent*, as those of Indian pink (*l'œillet d'Inde*), and many plants of the family of solaneæ (from solanum, the night-

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* The minuteness of the particles of bodies acting on the sense of smell has often been dwelt upon as a striking example of the divisibility of matter. Sulphuretted hydrogen in the atmosphere, in the proportion of one to a million, is distinctly perceptible. Ammonia is perceptible in the proportion of 1 to 33,000.

The following minute quantities of different substances spread out on the surface of smell cause a distinct sensation;—of phosphuretted hydrogen $\frac{1}{3000}$ gr.; of sulphuretted hydrogen $\frac{1}{30,000}$ gr.; of Bromine $\frac{1}{40,000}$ gr.; of oil of resin $\frac{1}{1,300,000}$ gr. A still smaller quantity of musk than the last given, smells strongly; but the actual measure has not been ascertained.—(Valentin.)

shade); 7th. *nauseous*, as the gourd, the cucumber, and those of its class.'—LONGET, p. 151.

Of several classifications quoted by the same author, the above seems to me the best, but even that one is by no means free from objections. The three first classes, the aromatic, fragrant, and ambrosiac, do not appear to have very strongly marked differences; nor is the distinction between fetid and nauseous a generic one.

As in describing taste, I shall proceed upon the plan of stating,—first, the odours that owe their character to sympathy with the vital organ in alliance with the sense, namely the Lungs; secondly, those that have a purely Olfactory sensibility; and thirdly, those involving an excitation of the nerves of Touch.

7. *Fresh* odours, those that have an action akin to pure air, or coolness in the midst of excessive heat; an action mainly respiratory, or tending to increase the activity of the lungs, and with that the physical energy of the system. Many of the balmy odours of the field and the garden have this effect; eau-de-Cologne and other, but not all, perfumes are included in the same class. We may recognise them by their effect in stimulating and reviving the system under the oppression and suffocation of a crowded assembly. Such odours are not always fragrant in their character, for we might cite cases of unpleasant effluvia that seem to refresh and stimulate the system. The odour of a tan-yard is perhaps a case in point. The nervous connexions of the nostrils with the lungs enable this reaction of the one upon the other to take place. Or the influence of the gases may be on the surface of the lungs rather than in the nose, a thing not at all unlikely in many cases coming under both freshness and the opposite. On this supposition, these would be smells falsely so called, and would correspond to the relishes and disgusts described under taste.

8. The opposite of freshness is shown in the *close* or suffocating odours. The effluvia of crowds, by acting on the lungs, have pre-eminently this damping and discouraging

action on the powers of life, whence it is that we seek the open air, and the solitudes of nature, to shake off the depression of rooms and of cities. The effluvia of warehouses, stores, and mills, where cotton, wool, cloths, &c., are piled up, and ventilation is defective, are of a like unwholesome description. The smell of a pastrycook's kitchen is peculiarly sickening. The action of highly-heated iron stoves seems of the same nature ; also the smell of a woollen screen when held too close to the fire. In these last instances, there is believed to be an evolution of the unwholesome and suffocating gas, cyanogen, from the destructive decomposition of the woolly particles floating in the air, or making part of the screen.

9. Although we may not be able to affirm that any class of odours stimulates the stomach by a direct influence, as fresh odours do the lungs, there can be no doubt about the existence of a class of the opposite kind, the disgusting or *nauseous* odours. That is to say, there are certain gases, of which sulphuretted hydrogen is an example and a type, that pervert the action of the alimentary canal, as some tastes do. It is doubtful, at least so far as my information goes, on what surface these effluvia operate, whether on the membrane of the nose exclusively, or partly on it and partly on the mucous surface of the tongue, throat, and stomach. But whatever be the seat of action, the fact in question is one sufficiently well marked to make the specific difference of a class.

10. It may be a question whether the foregoing classes are true and proper effects on the organs of smell ; no such ambiguity adheres to the odours that we term *sweet* or *fragrant;* these, therefore, I recognise as a general group with many varieties included under it. They represent the pure or proper pleasures of smell ; the enjoyment we are able to derive through the olfactory nerves and ganglion. They include the substances that convey along this channel to the mind a perfectly pleasurable stimulus. The sweetness may accompany freshness or it may not. The odour of the violet I take as a pure instance, there being many such among the flowering and fruit-bearing plants. The cases of sweet-

ness enjoyed with some other quality are also extremely numerous.

Sweetness is a name for a variety of pleasures. Derived originally from taste, it is extended to smells, to sounds, and to several of the higher emotions, such as the tender affections, and the beautiful in nature and in art. There must be a certain kindred character in all these; we find a strong tendency in the sensations to suggest the emotions. They are a class of feelings wherein we are most completely passive; to this extent they agree with muscular repose, warmth, and digestion; but they are more persisting and recoverable than the organic states, which gives them one of the points of superiority indicated by the term 'refinement.'

11. The opposite of sweet in odours can only be described by the general name *stinks;* the expressive word bitter is not usually applied to smell. The term 'mal-odour' has been proposed, and would be a convenient word. If we leave out both the nauseous odours, and certain other forms of the disagreeable to be afterwards described, this class will be limited considerably. Assafœtida may be given as an example of an odour intensely repulsive by its action on the olfactory nerves alone. The cadaverous odour is of the repulsive kind, but it is only one of many forms of disagreeable effluvia arising from animal decay. The aroma of some plants as those quoted by Linnæus, has an intensely unpleasant action. The disagreeable marsh smell may be experienced in its strongest form by squeezing in the fingers the brown scum of a stagnant pond, and applying them to the nose. The varieties of bad odours are endless.

As sweetness is the proper pleasure of smell, the effect of a stink is the proper pain of the organ, the influence originating the peculiar form of misery that we are adapted to receive by means of this sense. The sensation may be specified as the nose-pain. Of an intense, rather than a massive character, we are stunned and discomposed, but not necessarily depressed or prostrated by it. It resembles in this respect a bitter taste, and is contrasted with the massive pains of chillness, indigestion, or disgust. The expression is in accordance with the acuteness of the sensation, being an intense contortion of the features, chiefly about the nose. A sort of hysteric smile may likewise be provoked.

The peculiar feeling of an ill smell is often appealed to metaphorically to express the feelings caused by human conduct.

12. The name *pungent* is applicable to a large class of odours, and enters as an ingredient into many more. Ammonia is the type of substances producing this sensation. Nicotine, the snuff odour, is the best known example, a substance having a chemical analogy to ammonia. Many of the acid effluvia have a pungent action. This effect, however, is not an olfactory effect in the proper sense of the word; like astringency and acidity in taste, it would probably arise through the nose independently of the power of smell. Snuff-takers are often devoid of smell; they lose the sense of sweet or repulsive in odours properly so called, but are still susceptible of the nicotine pungency. The influence flows through the same channel to the brain, and is of the same nature, as pricking the nose, or pulling out hairs, being conveyed by the nerves of common sensation.

Nevertheless, the excitement of pungency is a characteristic variety of the human consciousness, a species of agreeable sensation interesting to study. It shows the effect of a sharp mechanical irritation of the nerves that does not amount to acute pain. A scratch, or a blow on the skin, an electric spark, a loud crash, a brilliant flame, a scorching heat, are all pungent effects, and seem to owe the pleasure they cause to the general excitement they diffuse over the system, and the lively expression that they give birth to. They rouse the system from ennui to enjoyment; they are a species of intoxication. They exalt, for the time being, the tone of the mind. They come therefore to be one of the cravings associated with ennui, or depression of mind; they are likewise a stimulus for bringing out the exuberance of the animal spirits among the young and vigorous, and those that lead a 'fast' life.

13. The *ethereal* is a distinct variety of the sensations of smell, and is probably a mixture of pungency with odour strictly so-called. Alcohol and the ethers, including chloroform and the substance first employed as an anæsthetic, will recall this effect. There can be no question but that alcohol and the vinous aromas have true odours; most probably, however, they have an influence upon other nerves than the olfactory; just as the fiery taste attributed to them is something beyond the gustatory feeling. At all events the odour is a distinct one, and is very different from the odours of vegetation and the common perfumes. It is not destitute of sweetness, but something besides sweet is wanting to express it.

The sulphurous and electrical odour is not radically different from the above class, so far as I am able to discriminate it. This odour has been traced to a particular substance discovered by Professor Schönbein and named by him *ozone*, from the Greek word signifying to smell.

If we were to recognise a class of *acrid* odours, they would only be a mixture of pungency and bad smell; like many of the so-called *empyreumatic* odours resulting from the action of heat on vegetable bodies, as in the manufacture of coal gas.

14. The *appetising* smells might be treated as a class apart from the rest. The smell of flesh excites the carnivorous appetite, and rouses the animal to pursuit. We may probably consider this influence as similar in its working to the first taste of savoury food; by the law of feeling-prompted movement, it sets on the activity for an increase of the gratification. A savoury smell may partly give a commencing pleasure of digestion, and partly bring out into keenness and relief the sense of hunger; in either case it would fire the energy of pursuit towards the full fruition. The sexual excitement in some animals is induced by smell. Sympathy and antipathy are alike generated by odours. The influence of odours upon the voluptuous tender emotions has not escaped the notice of the poets. Cabanis observes that the odours of young animals are of a kind to attract, and, he considers, even to invigorate, the older.

15. Tastes, properly so called, affect only the gustatory nerves, and are therefore the same whether the nostrils are opened or closed. But many sapid bodies are also odorous, and in the act of expiration accompanying mastication, especially the instant after deglutition, the odorous particles are carried into the cavities of the nose and affect the sense of smell, or make their odour apparent. This effect is what we term *flavour*. Some bodies, as cinnamon, have no taste, but merely a flavour, in other words an odour, which mastication brings out.

16. Smell, like taste, is an important instrument in the discrimination of material bodies, and therefore serves a high function in guiding our actions and in extending our knowledge of the world. Man does not exemplify the highest development of this organ. The order of ruminants, certain of the pachydermatous animals, and above all the carnivorous quadrupeds, excel the human subject in the expansion given to the membrane of the nose, and in a corresponding sensibility to odours. The scent of the dog is to us almost miraculous; it directs his pursuit, and tells him his whereabouts. It may act the part of sight in enabling him to retrace his steps or to find out his master.

SENSE OF TOUCH.

1. Physiologists in describing the senses not unusually commence with Touch. 'This,' say Messrs. Todd and Bowman, 'is the simplest and most rudimentary of all the special senses, and may be considered as an exalted form of common sensation, from which it rises, by imperceptible gradations, to its state of highest development in some particular parts. It has its seat in the whole of the skin, and in certain mucous membranes, as that of the mouth, and is therefore the sense most generally diffused over the body. It is also that which exists most extensively in the animal kingdom; being, probably, never absent in any species. It is, besides, the earliest called into operation, and the least complicated in its impressions and mechanism.'

It may well be admitted that Touch is less complicated than Taste, where four different kinds of sensations may be said to meet, the tactile being one of them. It may be further said of touch, that the mode of action (mechanical contact or pressure), is the most simple and intelligible of any that we find giving rise to sensation. Nevertheless, there is one consideration that has prevailed with me in giving it a place subsequent to organic sensibility, taste, and smell. Touch is an intellectual sense of a far higher order than these. It is not merely a knowledge-giving sense, as they all are, but a source of ideas and conceptions of the kind that remain in the intellect and embrace the outer world. The notions of the size, shape, direction, distances, and situation of external bodies may be acquired by touch, but not by either taste or smell.

But this last assertion must be accompanied by an important explanation. Touch, considered as a source of ideas such as those, is really not a simple sense, but a compound of sense and motion; and it is to the muscular part of the sense, or to the movements of the touching organs, that these conceptions owe their origin and their embodiment, as we have endeavoured to show in the previous chapter. The superiority of touch to taste and smell, in this view, therefore, consists in its union with movement and muscular sensibility; and the same advantage pertains to sight. The contact of solid bodies with the surface of the body gives occasion to the exercise of movement, force, and resistance, and to the feelings and perceptions consequent on these; which cannot be said of smell, nor of taste properly so-called.

A second feature marking the superiority of the sense of Touch, and qualifying it to furnish intellectual forms and imagery, is the distinctness or separateness of the sensations felt over the different parts of the skin. The sensations of the different parts of the surface of smell, would seem all to fuse into one stream of sensibility; it is not possible ever to refer a smell to any one portion of the membrane more than another. But the sensations of the skin are conveyed by distinct nervous filaments; each little area of skin has a separate nerve, and an independent communication with the nerve centres, whereby we can, after a little education, refer each sensation to the spot where the contact is made. The stimulus on one finger is not, at any part of the course of the nerve, confused with the stimulus on another finger; the back can always be distinguished from the breast, the right side from the left, and so on. I shall afterwards endeavour to show that this localization of touches has to be learned by practice; but the very possibility of it rests upon the distinctness and independence of the nerve filaments. This is an extremely important fact, and makes the great difference between touch and what is called common sensation, or the sensibility diffused over all the internal organs and tissues. There is no such distinguishing sensibility in the stomach, or the lungs, or the liver; at all events, the distinctness of the nerves in those parts is very low in degree, just sufficient to enable us to refer a pain to the lungs, the liver, or the stomach, without indicating the particular region or subdivision. The skin is therefore marked by a great exaltation of the common sensibility of the body, not as regards intensity of feeling, but as regards distinctiveness of locality.

2. Having made these preliminary remarks, we commence as usual, with the *objects*, or external agents concerned in the sense of Touch. These are principally the *solid* substances of the outer world. Gases do not act on the touch unless they are blown with great violence. The pressure of the atmosphere gives rise to no feeling, excepting from its temperature, Liquids also give very little feeling, if they are of the same warmth as the body. The sensations of a bath are confined to heat or cold. It is manifest that an even, equal pressure. such as fluids give, is not sufficient to impress the tactile nerves. The asperities and inequalities of solid surfaces, by pressing intensely on some points and not at all on others, are requisite for this purpose.

The hard unyielding nature of the mineral constituents of the earth's crust, metals, rocks, &c., are particularly well fitted to excite the touch. The woody fibre of the vegetable world has a compactness next in degree to the solid minerals. The soft and yielding class of solids impress the surface in a totally different manner: and these differ among themselves according as they recover their form after pressure, or not; whence the distinction of elastic and non-elastic. When the substance is moved over the skin, the asperities come to be felt more acutely, and hence the further distinction into rough and smooth surfaces. In treating of the sensations themselves, we shall attend to these qualities more minutely.

3. The *sensitive organ* or surface is the skin, or common integument of the body, the interior of the mouth, and the tongue. The parts of the skin are its two layers, its papillæ, the hairs and nails, its two species of glands,—the one yielding sweat, the other a fatty secretion,—with blood vessels and nerves. I shall quote a few extracts from the anatomical description of those parts. Of the two layers, the outermost is the *cuticle, epidermis,* or *scarf skin.* 'It forms a protective covering over every part of the true skin, and is itself quite insensible and non-vascular. The thickness of the cuticle varies in different parts of the surface, measuring in some not more than $\frac{1}{240}$, and in others from $\frac{1}{24}$ to $\frac{1}{12}$ of an inch. It is thickest in the palms of the hands and soles of the feet, where the skin is much exposed to pressure, and it is not improbable that this may serve to stimulate the subjacent true skin to a more active formation of epidermis; but the difference does not depend solely on external causes, for it is well marked in the fœtus.

'Many of the cells of the cuticle contain pigment, and often give the membrane more or less of a tawny colour, even in the white races of mankind; the blackness of the skin in the negro depends entirely on the cuticle. The pigment is contained principally in the cells of the deep layer, and appears to fade as they approach the surface, but even the superficial part possesses a certain degree of colour.

'The *true skin, cutis vera, derma,* or *corium,* is a sentient and vascular texture. It is covered and defended by th insensible and non-vascular cuticle, and is attached to the parts beneath by a layer of cellular tissue, named "subcutaneous," which, excepting in a few parts, contains fat, and has therefore been called also the "panniculus adiposus." The connexion is in many parts loose and movable, in others close and firm, as in the palmar surface of the hand and the sole of the foot, where the skin is fixed to the subjacent fasciæ* by numerous stout fibrous bands, the space between being filled with a firm padding of fat. In some regions of the body the skin is moved by muscular fibres, which, as in the case of the orbicular muscle of the mouth, may be unconnected to fixed parts, or may be attached beneath to bones or fasciæ, like the other cutaneous muscles of the face and neck, and the short palmar muscle of the hand.'

The upper or free surface of the true skin 'is marked in various places with larger or smaller furrows, which also affect the superjacent cuticle. The larger of them are seen opposite the flexures of the joints, as those so well known in the palm of the hand and at the joints of the fingers. The finer furrows intersect each other at various angles, and may be seen almost all over the surface; they are very conspicuous on the back of the hands. These furrows are not merely the consequence of the frequent folding of the skin by the action of muscles or the bending of joints, for they exist in the fœtus. The wrinkles of old persons are of a different nature, and are caused by the wasting of the soft parts which the skin covers. Fine curvilinear ridges, with intervening furrows, mark the skin of the palm and sole; these are caused by ranges of the papillæ, to be immediately described.

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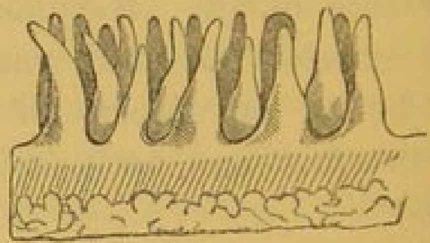
* 'Fibrous membranes, named 'aponeuroses,' or '*fasciæ*,' are employed to envelope and bind down the muscles of different regions, of which the great fascia enclosing the thigh and leg is a well known example. The tendons of muscles, too, may assume the expanded form of aponeuroses, as those of the broad muscles of the abdomen, which form strong fibrous layers in the walls of that cavity, and add to their strength.'—QUAIN, p. xciii.

'*Papillæ.*—The free surface of the corium is beset with small eminences thus named, which seem chiefly intended to contribute to the perfection of the skin as an organ of touch, seeing that they are highly developed where the sense of touch is exquisite, and *vice versâ*. They serve also to extend the surface for the production of the cuticular tissue, and hence are large-sized and numerous under the nail. The papillæ are large, and in close array on the palm and palmer surface of the fingers, and on the corresponding parts of the foot. There they are ranged in lines forming the curvilinear ridges seen when the skin is still covered with its thick epidermis. They are of a conical figure, round or blunted at the top, and are received into corresponding pits on the under surface of the cuticle. They measure on the hand from $\frac{1}{200}$ to 1 of an inch in height. In the ridges, the large papillæ are placed sometimes in single but more commonly in double rows, with smaller ones between them, that is, also on the ridges, for there are none in the intervening grooves. These ridges are marked at short and tolerably equal intervals with notches, or short transverse furrows, in each of which, about its middle, is the minute funnel-shaped orifice of the duct of a sweat gland. Fine blood vessels enter the papillæ, forming either simple capillary loops in each, or dividing, according to the size of the papillæ, into two or more capillary branches, which turn round in form of loops, and return to the veins. Filaments of nerves are also to be discovered ascending into the papillæ, but their mode of termination is doubtful. In other parts of the skin, endowed with less sensibility, the papillæ are smaller, shorter, fewer in number, and irregularly scattered. In parts where they are naturally small, they often become

FIG. 6.*



* 'Papillæ of the palm, the cuticle being detached.—Magnified 35 piameters.'—(TODD and BOWMAN.)

enlarged by chronic inflammation round the margin of sores and ulcers of long standing, and are then much more conspicuous.'—QUAIN, pp. cclix.—cclxiv.*

I have quoted the description of the papillæ at length because of their connexion with the sensibility of the skin. I shall refrain from quoting the minute account of the nails and hairs, however interesting their structure in other points of view. Respecting the glands, it is only necessary to advert to the totally different nature of the two sorts, as respects the material secreted. The *sweat* glands are enormously numerous, and exist in all regions of the skin; they are reckoned to vary from 400 to 2,800 in a square inch. 'The *sebaceous* or oil glands pour out their secretions at the roots of the hairs, for, with very few isolated exceptions, they open into the hair follicules, and are found wherever there are hairs.'

4. With respect to the functions and vital properties of the skin in general, I quote part of Dr. Sharpey's summary.

'The skin forms a general external tegument to the body, defining the surface, and coming into relation with foreign

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* Inside the papillæ are either nerves or blood vessels, seldom both; and at their base, the nerves are disposed in the form of net-work. In great part of the skin, the nerves cannot be traced farther than this netunk; it is in the hands, feet, lips (red part), and tongue that they are followed into the interior of the papillæ. In these parts they end in a peculiar structure, known as the 'little body of touch,' discovered by Wagner and Meissner. These are little sacks, covered by a thin skin, and filled with a round little mass. The skin is pierced by one or two nerves, which often wind spirally, but end by dividing and spreading their twigs in the little sack. These bodies lie in the interior of papillæ destitute of blood vessels, in such a manner as to project far above the upper end of the papillæ, and in immediate contact with the cuticle. They are most numerous on the inside of the finger tips, and decrease towards the palm; the same happens with the foot. Meissner found in a square line ($\frac{1}{144}$ of a square inch) on the index finger, 108 on the last joint, 40 on the second, 15 on the first. In the red part of the lips, the papillæ carrying nerves are not distinguishable from those carrying blood vessels, the same papilla appearing to have both.

The little muscles discovered by Kölliker in the skin, and especially in the glands, excite peculiar movements as in shivering, the creeping sensation, &c. These are especially affected by changes of temperature, and may serve to regulate the supply of blood under such changes.

matters externally, as the mucous membrane, with which it is continuous and in many respects analogous, does internally. It is also a vast emunctory, by which a large amount of fluid is eliminated from the system, in this also resembling certain parts of the mucous membrane. Under certain conditions, moreover, it performs the office of an absorbing surface; but this function is greatly restricted by the epidermis. Throughout its whole extent the skin is endowed with *tactile sensibility*, but in very different degrees in different parts. On the skin of the palm and fingers, which is largely supplied with nerves and furnished with numerous prominent papillæ, the sense attains a high degree of acuteness; and this endowment, together with other conformable arrangements and adaptations, invests the human hand with the character of a special organ of touch. A certain, though low degree of vital contractility, seems also to belong to the skin.'—QUAIN, p. cclxxvii.

Of the other parts sensible to Touch, besides the skin, namely, the tongue and mouth, the needful description has been already furnished under the sense of Taste.

The nerves of touch are the sensory or posterior roots of the spinal nerves for the limbs and trunk, and certain of the cerebral nerves (the fifth pair) for the head, face, mouth, and tongue.*

5. The *action* in touch is known to be simple pressure. The contact of an object compresses the skin, and through it the embedded nerve filaments. That the squeezing or pinching of a nerve can produce sensibility is proved in many experiments: in touch, the squeezing is of a more gentle nature, owing to the protection that the covering of skin gives to the nerves. The only point of interest connected with the mode of action is the singular fact, that very light contacts

* It is supposed that the important nerves of touch in the extremities have a different course in the brain from the nerves of the trunk. Türk has shown that in the hand and foot the same spot is supplied from different roots in the spinal cord.

often produce a great sensibility, as the touch of a feather, or of a loose hanging piece of dress, which sensibility is diminished by making the contact more intense. Great pressures yield comparatively little sensation in the skin ; they are felt mainly in the muscles as a feeling of force and resistance.

This fact of the disproportion of the feeling to the pressure I can account for in no other way than by supposing, that great compression has an effect in deadening the conducting property of the nerve. We know from various observations that the compression of a nerve does tend to arrest its conductibility ; the deadening of the sensibility of the hand by leaning the elbow on a table, so as to squeeze the nerve that passes near the surface on the elbow joint, is a familiar instance.

6. We come now to the Sensations, or feelings of touch, which are various in kind, and have many of them a considerable degree of interest, from their bearing on the higher operations of mind. In the order of enumeration, I shall commence with those having reference to pleasure or pain.

Sensations of Soft Touch.—In this class of feelings, we suppose the contact of some extended surface with the skin, with no reference to the special character of the surface, and no more pressure than is sufficient for closeness of contact. I keep out of view the feeling of temperature. A good example is furnished by the contact of the under clothing with the general surface of the body, which is most perfect under the bedclothes at night. The glove not too tight on the hand is an instance. The extended hand, resting on a cushion, or other soft body, is a sufficiently good type of the situation.

The resulting emotion may be described as of the pleasurable kind, not highly acute or intense, but of some considerable massiveness or volume. The peculiar quality of the pleasure may be illustrated by a comparison with gentle warmth, to which there is a close resemblance. The sensation is far inferior in power to the muscular and digestive feelings, and is of itself insufficient to give a prevailing tone to the consciousness, even when most fully experienced ; we obtain from it, nevertheless, a felt contribution to the sum of sensuous enjoyment. Custom and inattention blunt our sensibility to it, but the contrasted state of nakedness reminds us again of its power. The blank sensation of the naked body is owing principally to the deprivation of touch. We cannot appreciate the full force of an extended contact without expressly attending to it, and this we rarely do. When our consciousness is fully alive to the state, we discern a close connexion between it and the tender emotions, whence we find it suggesting these to the mind.

7. *Pungent and painful Sensations of Touch.*—When, instead of a diffusive soft contact, we have an intense action on limited spots, mere points, as in the stroke of a whip, a sensation of smartness is produced very different from the above. In moderate degree, this gives a pleasurable pungency, beyond which it is acutely painful. The nerves are shocked as by the prick of an instrument, and the over-intensity and suddenness of the stimulus is a cause of pain. The nature of the sensation is not radically different from a cut in the skin ; its peculiar smartness diffuses an excitement over the system. The retractation of the part would seem partly reflex, and partly the result of the general movement of the body that constitutes the expression of the feeling. It prompts the most decisive actions for avoiding the pain, and an intense mental aversion to all that relates to it. The intensity gives to it a hold in the memory not possessed by the luxurious feeling of diffused softness. Hence the efficacy of skin inflictions in the discipline of all orders of sensitive beings.

The sensibility of the skin to these two classes of feelings is greatest in parts most richly supplied with nerves, and where the discriminative or tactile sensibility is greatest, as in the tongue, the lips, and the palm of the hand.

8. *Sensations of Temperature.*—Excepting in surfaces of the same degree of temperature as the skin, these feelings must enter into every instance of touch. As sensations, we have already described them among the organic feelings ; we

need only to remark here, that the skin is extremely liable to this influence, and is very susceptible to it ; probably as much so, as to the effects above described. There is no reason for supposing that any other nerves than those of touch are needed to rouse a sensation of warmth or of coolness, although the action is doubtless in some degree peculiar. This action, however, if we look at it closely, may still be viewed as of a mechanical kind ; for the chief influence of slight alterations of temperature is to expand or contract the material affected. In the human body, great heats and great colds derange the structure of the tissues, and are extremely painful ; but the smaller changes may have no more than the mechanical effect now supposed.*

As regards the discrimination of degrees of Temperature, it appears that we are equally sensitive at high and at low points of the thermometer. According to Weber, we can discriminate 14° Reaumur from 14.4°, as well as 30° from 30.4° ; but the discrimination is all the better by the change being rapidly made. It is also better when the unequal tem-

* Sir William Hamilton thinks it probable that the sensation of heat depends on a peculiar set of nerves, for two reasons: '1st, Because certain sentient parts of the body are insensible to this feeling ; and, 2nd, Because I have met with cases recorded, in which, while sensibility in general was abolished, the sensibility to heat remained apparently undiminished.'—REID, p. 875.

On the other hand, the experiments of Weber, while leading to the conclusion that the integrity of the skin is necessary to the discrimination of degrees of temperature by touch, give no ground for supposing that any other nerve fibres than those of common tactile sensation are necessary.—CARPENTER'S *Human Physiology*, 4th edition, § 866.

Brown-Séquard is of opinion that, in the spinal cord, the channel for conducting impressions of temperature is different from that for tactual impressions.

It may be remarked that the discriminative sensibility of the skin, shown in the feeling of plurality of impressions, implies an internal or central organization for receiving, independently, the stimuli of the different parts. Now, an internal derangement may vitiate this independent conveyance of impressions without destroying the sensibility of the fibres to the impulses of heat, or cold, or other strong irritation. It has been already noticed (Nervous System, § 19) that when the thalami optici are injured, tactile sensation is lost, but not the sensibility to pain.

peratures are applied at the same time to contiguous parts, than when the parts touched are remote from each other. The sensitiveness of different parts to temperature is not solely dependent on the abundance of nerves supplied to the part; some other circumstance at present unknown is in operation. Weber's graduated scale for heat is as follows :—tip of the tongue, eyelids, lips, neck, trunk. In the face, breast, and abdomen, the central parts are less sensitive than the sides.

The sensitiveness is increased by affecting a greater surface. In an experiment with dipping the finger into water at 32° R., and the whole hand in $29\frac{1}{2}$°, the latter appeared the warmer of the two.

It is remarked that when one part of the body touches another, the temperature being the same, the part endowed with the finer tactile power feels the other. If the temperatures are different, the first feels the second tactually, while the second feels the temperature of the first. The hand is not felt tactually by the brow, nor is the coldness of the brow felt by the hand.

It is a singular fact, discovered by Weber, in conection with the sense of temperature, that when two substances of the same weight, but of different temperatures, are estimated by the sense of touch or of pressure, the colder appears the heavier. The depressing effect of the cold chill upon the mind may be the explanation. This is somewhat analogous to the perversion of our estimate of time by an unusual elation or depression of the general mental tone; in the one case we imagine it to pass rapidly, in the other slowly.

The sensation of wetness seems to be nothing else than a form of cold.

The mutual contact of living animal bodies yields a complex sensation of softness and warmth, and excites the corresponding emotions. There may be in addition magnetic or electric influences of a genial kind, but the reality of such currents is by no means established.

9. *Other painful Sensations of the Skin.*—Among these I

would first advert to the sensation of tickling. On this Weber remarks, that the lips, the walls of the nasal openings, and the face generally, when touched with a feather, give the peculiar sensation of tickling, which continues till the part is rubbed by the hand. In the nose, the irritation leads at last to sneezing. The excitation extends to the ducts of the glands, which pour out their contents, and increase the irritation. The violent sensation produced by bodies in contact with the eye, is of the nature of tickling, accompanied by a flow from the glands, and readily passing into pain. Why some places are liable to this sensation, and others not, it is difficult to explain. The possession of delicate tactual discrimination is not necessary to the effect.

All the parts of the skin are liable to yield painful sensations, especially under injury or distemper. The epidermis is itself insensible, but the true skin is extremely alive to feeling. When lacerated, chafed, or burnt, it causes acute pains. Its capillary vessels and numerous sweat glands and oil glands are, in all probability, the source of organic sensations of cheerfulness or oppression, according as they are working well or ill. The hairs are themselves insensible, but by their attachment to the skin they are the media of sensation. The place of attachment of the nails is the seat of a violent form of acute pain, which has a fatal facility of seizing on the imagination, and exciting revulsion even in idea.

We pass now to the more intellectual sensations of Touch.

10. *Impressions of distinguishable Points.*—I have already called attention to the discriminative or articulate character of the sense of touch, whereby it receives distinguishable impressions from the variously situated parts of an extended surface. Very interesting differences in the degree of this discrimination are observable on different parts of the surface of the body, which have been especially illustrated by the experiments of Weber.

'These consisted in placing the two points of a pair of compasses, blunted with sealing wax, at different distances asunder, and in various directions, upon different parts of the skin of an individual. It was then found, that the smallest distance at which the contact can be distinguished to be double, varies in different parts between the thirty-sixth of an inch and three inches; and this seems a happy criterion of the acuteness of the sense. We recognise a double impression on very sensible parts of the skin, though the points are very near each other; while, in parts of less acute sensibility, the impression is of a single point, although they may be, in reality, far asunder.

'In many parts we perceive the distance and situation of two points more distinctly when placed transversely, than when placed longitudinally, and *vice versâ*. For example, in the middle of the arm or fore-arm, points are separately felt at a distance of two inches, if placed crosswise; but scarcely so at the distance of three, if directed lengthwise to the limb.

'Two points, at a fixed distance apart, feel as if more widely separated when placed on a very sensitive part, than when touching a surface of blunter sensibility. This may be easily shown by drawing them over regions differently endowed; they will seem to open as they approach the parts acutely sensible, and *vice versâ*.

'If contact be more forcibly made by one of the points than by the other, the feebler ceases to be distinguished; the stronger impression having a tendency to obscure the weaker, in proportion to its excess of intensity.

'Two points, at a fixed distance,are distinguished more clearly when brought into contact with surfaces varying in structure and use, than when applied to the same surface, as, for example, on the internal and external surface of the lips, or the front and back of the finger.

'Of the extremities, the least sensitive parts are the middle regions of the chief segments, as in the middle of the arm, fore-arm, thigh, and leg. The convexities of the joints are more sensible than the concavities.

'The hand and foot greatly excel the arm and leg, and the hand the foot. The palms and soles respectively excel the opposite surfaces, which last are even surpassed by the lower parts of the fore-arm and leg. On the palmar aspect of the hand, the acuteness of the sense corresponds very accurately with the development of the rows of papillæ; and where these papillæ are almost wanting, as opposite the flexions of the joints, it is feeble.

'The scalp has a blunter sensibility than any other part of the head, and the neck does not even equal the scalp. The skin of the face is more and more sensible as we approach the middle line; and the tip of the nose and red parts of the lips are acutely so, and only inferior to the tip of the tongue. This last, in a space of a few square lines,* exceeds the most sensitive parts of the fingers; and points of contact with it may be generally perceived distinctly from one another, when only one-third of a line intervenes between them. [The superior sensibility of the tip of the tongue to the finger, is illustrated by the familiar observation, that a hole in a tooth seems very much exaggerated when felt by the tip of the tongue.] As we recede from the tip along the back or sides of the tongue, we find the sense of touch much duller.

'The sensibility of the surface of the trunk is inferior to that of the extremities or head. The flanks and nipples, which are so sensitive to tickling, are comparatively blunt in regard to the appreciation of the distance between points of contact. Points placed on opposite sides of the middle line, either before or behind, are better distinguished than when both are on the same side.

'The above are the results obtained by making the several parts mere passive and motionless recipients of impressions. They evince the precision of the sense in so far only as it depends on the organization of the tactile surface. The augmented power derived from change of position of the object with regard to the surface, is well illustrated by keeping the hand passive, while the object is made to move rapidly over it. In this case the contact of the two points is separately

* A line is $\frac{1}{12}$th of an inch.

perceived, when so close that they would, if stationary, seem as one. If, still further, the fingers be made to freely traverse the surface of an object, under the guidance of the mind, the appreciation of contact will be far more exquisite, in proportion to the variety of the movements, and the attention given to them. We are then said to *feel*, or to examine by the sense of touch.'—TODD and BOWMAN, I., 429-30.

These observations of Weber have been deservedly celebrated by physiologists, as the foundation of an accurate mode of estimating the tactile sensibility of the skin. They have been extended by other observers, as may be seen in Dr. Carpenter's article on Touch in the *Cyclopædia of Anatomy*.* It is necessary, however, for us to discuss more closely the

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* The following are a selection from Weber's measurements. The intervals are expressed in lines, a line being the twelfth part of an inch. The range according to Weber is from the twenty-fourth of an inch, in the tip of the tongue, to two and a-half inches. The range stated in the text is somewhat greater, being founded probably on a comparison of the extreme observations of different observers :—

Tip of the tongue,	$\frac{1}{2}$	of a line. ($\frac{1}{24}$ of an inch)
Tip of the forefinger, palmar surface,	1	"
Red surface of under lip,	2	"
Second joint of the fingers, palmar surface,	2	"
Last joint of the fingers, back or dorsal surface,	3	"
Tip of the nose,	3	"
Middle of the back of the tongue,	4	"
End of the great toe,	5	"
Palm of the hand,	5	"
Cheek, over the buccinator,	5	"
Lower part of forehead,	10	"
Back of the hand,	14	"
Crown of the head,	15	"
Thigh, by the knee,	16	"
Upper and lower extremities of the legs,	18	"
Breast,	20	"
Back of neck near occiput,	24	"
Middle of fore-arm, middle of thigh, middle of the back of the neck, middle of the back,	30	"

If the points are placed within the limit of doubleness and gradually separated, the interval that gives doubleness is greater than in the reverse process.

matters involved in them, and especially to discriminate the tactile from the muscular element of the sensations.

Whenever two points produce a double sensation, we may imagine that one point lies on the area supplied by one distinct nerve, while the other point lies on the area of a second nerve. There is a certain stage of subdivision or branching of the nerves of touch, beyond which the impressions are fused into one on reaching the cerebrum. How many ultimate nerve fibres are contained in each unit nerve, we cannot pretend to guess; but on the skin of the back, the middle of the thigh, and the middle of the fore-arm, an area of three inches diameter, or between six and seven square inches, is supplied by the filaments of a single unit. On the point of the finger the units are so multiplied, that each supplies no more than a space whose diameter is the tenth of an inch. Such units correspond to the entire body of the olfactory or gustatory nerve, for these nerves give but one undivided impression for the whole area affected. If we had two different regions of smell, and two distinct olfactory nerves, we should then probably have a feeling of doubleness or repetition of smells, like the sense of two points on the skin.

The primitive susceptibility to a plurality of distinct points, does not enable us to judge what the real distance of the points is; nor can we tell previous to experience whereabouts on the body the impression is made. Hence in those of the experiments that relate to our sense of the relative interval of the points, as when they pass from a duller to a more sensitive region, there are involved perceptions that we have got at in some other way than through the sense of contact. This other means is the feeling of movement or the muscular sensibility, without which it is impossible to comprehend fully the sensations of Touch.

Sensations of Pressure.—When a contact passes from the soft touch to a certain amount of energy of compression, the character of the sensation is entirely changed. It becomes indifferent as regards pleasure and pain, unless the pressure is on the verge of injuring the parts, when it becomes painful. The nerves of touch are of course affected, but probably not they alone. The compression may extend its influence to the nerves in the deep seated parts, that is, to fibres supplied to muscles, &c.

If the compressed limb is unsupported, its muscles re-act and give the feeling of resistance. If it is supported, as when the hand lies on the table, the effect is one of pressure solely, whether the nerves stimulated are those of the skin alone or of the skin and the interior tissues combined. The sense of pressure is found to have a certain power of discrimination, applicable to determine degrees of weight, hardness, elasticity, and other properties. The most sensitive parts, as the tips of the fingers, can distinguish 20 oz. from 19·2 oz.; the forearm distinguishes 20 oz. from 18·7 oz. The interval of time affects the discrimination, as we might suppose. The difference between 14, or even 14·5, could be distinguished from 15, within 30 seconds; 4 and 5 could be distinguished within 90 seconds.

The discrimination of pressures does not increase proportionably with the supply of tactile nerves.

11. *Sensations of Touch involving muscular perceptions.*—In discussing these, we shall begin with examples that are almost purely muscular, the tactile sensibility being a mere incident of the situation. The feeling of *weight* is of this description; depending on the sense of muscular exertion, although capable also of being estimated to some extent by the feeling of compression of the skin. On this last point, I add some further illustrations from Todd and Bowman. 'Weber performed experiments to ascertain how far we are capable of judging of weight by the mere sense of contact [without muscularity.] He found that when two equal weights, every way similar, are placed on corresponding parts of the skin, we may add to, or subtract from one of them a certain quantity without the person being able to appreciate the change; and that when the parts bearing the weights, as the hands, are inactively resting upon a table, a much greater

alteration may be made in the relative amount of the weights without his perceiving it, than when the same parts are allowed free motion. For example, 32 ounces may thus be altered by from 8 to 12, when the hand is motionless and supported; but only by from $1\frac{1}{2}$ to 4, when the muscles are in action; and this difference is in spite of the greater surface affected (by the counter pressure against the support) in the former than in the latter case. Weber infers that the measure of weight by the mere touch of the skin is more than doubled by the play of the muscles. We believe this estimate to be rather under than over the mark.'—p. 431.

That the discriminative sensibility of the skin to degrees of compression may operate in appreciating weight is further confirmed by the following statement. 'The relative power of different parts to estimate weight corresponds very nearly with their relative capacities of touch. Weber discovered that the lips are better estimators of weight than any other part, as we might have anticipated by their delicate sense of touch and *their extreme mobility*. The fingers and toes are also very delicate instruments of this description. The palms and soles possess this power in a very remarkable degree, especially over the heads of the metacarpal and metatarsal bones; while the back, occiput, thorax, abdomen, shoulders, arms, and legs, have very little capacity of estimating weight.' —*ib.* p. 432.

What is said of weight applies to any other form of pressure, force, or resistance. The impetus of a push or a squeeze received on the hand is measured by the muscular exertion induced to meet it, and in some small degree, as above described, by the compression of the skin and other parts at the place of contact.

It must not be supposed that we could derive our original feeling of resistance, with its reference to the object world, by mere tactile sensibility through pressure. The sense of resistance is primarily the feeling of expended energy. When the notion is once formed, we can remark that the degrees of resistance coincide with degrees of the tactile sensibility to pressure; and hence the passive feeling can suggest the active, and become a criterion of its amount.

The qualities of *hardness* and *softness* are appreciated by this combined sensibility; the one means a greater resistance to compression, and the other a less. From the unyielding stone or metal to the mobility of the liquid state, we have all degrees of this property; the entire class of soft, viscid, and fibrous substances lying between. It belongs to many of the manual arts to appreciate minute differences of consistence in the class of soft bodies; the pastrycook, the builder, the sculptor, &c. In this they are assisted by practice, which improves all sensibilities; but there are great varieties of natural endowment in the case, which varieties must have their seat principally in the muscular tissue, and secondarily, in the skin and the nerves of the hand.

The feeling of *elasticity* is only a case of simple resistance to force, exerted in the particular circumstance of a rebound or reaction from pressure. The elasticity implies a perfect return to the original position; air is elastic, and so is steel and ivory, meaning that when in any way compressed or distorted, they recover themselves. The softness that is agreeable to rest upon must be an elastic softness; we can note the difference by comparing a hair cushion with a lump of clay.

We may next consider the sensations rising out of the qualities of *roughness* and *smoothness*. Simple contact, we have seen, gives the sense of a multiplicity of points. The finger resting on the end of a brush would make us aware of its character; that is we should have the feeling of a plurality of pricks. In this way we are sensitive to rough and pointed surfaces. We can distinguish between bluntly-pointed asperities, like a file, and sharp points like a horse-comb: the sensibility of a blunt point being distinct from a needle-prick. We can also distinguish between thick-set points and such as are more scattered, provided they are not too close for the limits of sensibility of the part, that is one-twelfth of an inch for the finger, and one twenty-fourth to one thirtieth for the tip of the tongue. On the back, the calf of the leg, and the middle of the fore-arm, where points are confounded up to the distance of two and a half to three inches, roughness would be altogether imperceptible.

In these instances, the thing touched is supposed to lie at rest on the finger, or on the part touched. But this does not do full justice to the tactile sensibility; it is requisite that we should move the finger to and fro over the surface, in order to try to the utmost the power of discrimination. By this means we may discriminate far nicer shades of roughness; we may in fact appreciate minuter intervals than in the resting position. Supposing the sensibility of the tip of the finger to be one line at rest, by motion we can extend this sensibility to an unknown limit. The case may be illustrated by the micrometer screw on an astronomical instrument. The divisions on the limb of the instrument extend we may suppose to one minute of a degree, and if the index lie between two divisions, its place can be measured by the number of turns of the screw required to bring it up to one of the divisions. So, if a point is undistinguished on the finger in consequence of not being a line removed from the neighbouring point, we may estimate its distance, nevertheless, by the amount of motion of the finger needed to bring it into the limit of sensibility. I will take as an example a row of points, one-fortieth of an inch apart, the extremes being one-tenth, which is the sensibility of the tip of the finger. This row would be felt as two points if the finger were stationary. But by the motion of the finger one point would pass away and another would come up, and there would be a feeling of the interval moved over between the perception of the successive points, which would be a measure of the intervals. The sense of movement would thus be brought in to aid the tactile feeling, and to reveal a degree of closeness in asperities beyond the reach of touch unassisted by motion. It is agreeable to all experience, that the roughness of a surface becomes far more apparent by drawing the hand over it; whether the sense of movement explains all that there is in this increased sensibility, I will not undertake to say. For we must consider that friction creates a new variety of pressure on the skin and nerves, and the kind of friction is so different for a smooth and for a rough body, that by it alone we might learn to distinguish between the rough and the smooth contact.

If any one will make the experiment of drawing over the finger two points, so close that to the touch they seem one when at rest, it will be found that the motion gives the feeling of doubleness. What is the limit of this, for a limit there is, it would take a considerable amount of observation to decide. I venture to affirm that at least half the interval will become sensible by the motion of the points, the motion being by bringing them in train, and not abreast of one another.

Whatever may be the explanation of the increase of sensibility due to movement, the fact is an important one. A vast amount of discrimination turns upon it. From the variety of trace made by different kinds of surface, we can distinguish them or identify them at pleasure, up to a considerable limit of delicacy. Hence the power of telling substances by the feel, and of deciding on the qualities and merits of texture and of workmanship. Degrees of polish in stone, metal, or wood, the fineness of cloths, wool, &c., the beat of a pulse, the quality of powdered substances, and many things besides, are matters of judgment and comparison to the touch, and put to the proof its natural or acquired delicacy.

The feeling of temperature is an element in many discriminations, as in the distinction between stone and wood.

Clamminess is a distinct sensation arising from the adhesion of a substance to the skin, and is an uneasy feeling, the uneasiness being due to some interruption of the natural functions of the part.

These tactile sensations whereby surfaces are discriminated, have a great degree of persistence in the recollection; something intermediate between tastes or smells, and sights. We do not revel in them as imagery, it is true, but this would be accounted for by the superior hold that we have of the very same objects by means of sight. With the blind the case is different; to them the outer world must be represented as outspread matters of contact; their visions of the surfaces of all things are visions of touch.

Our permanent impressions of touch serve us for comparing present surfaces with remembered ones, and for identifying or distinguishing the successive objects that come before the view. The cloth dealer sees whether a given specimen corresponds with another piece that passed through his hands a year ago, or with a permanent standard impressed upon his finger sensibility.

12. *Qualities of Extension, Size, Form, &c.*—I have endeavoured to show in the previous chapter, that these qualities are impressed upon us by the movements they cause, and that the feelings they produce are feelings of movement or muscularity. It is now to be seen how far the sense of Touch proper, enters into our notions of the fundamental property of the object world, namely EXTENSION, of which Distance, Direction, Position, and Form are only special modes or applications.

When we examine closely the sensibilities obtained by movement alone, as by passing the arm to and fro in empty space, we find that these have various short-comings as regards the idea of extended matter, or extended space.

In the first place, the absence of some definite marks to indicate the commencement and the termination of a muscular sweep, leaves a certain vagueness in our feeling of mere movement. The feelings of putting forth power, and of this power taking the form of movement as distinct from dead strain, are present in all cases; but the mind is more alive to them when some definite impression marks where we begin and where we cease. Now the sense of touch supplies this impression, and furnishes, as it were, a call to attention. Let us suppose the hand moving between two fixed obstacles, for example, from one side of a box to another. There is, to commence with, the contact with one side of the box felt more or less as a sense of touch, pressure, and resistance; the abrupt departure from this state is a mark in consciousness, a call to attention, and the mind is awakened to the feeling of movement that follows. After a time, the other side is struck, and the mind is again roused, and takes note of the cessation of the movement. The antithesis of resisting matter and unresisted movement is well brought out by such an experience; there is in it something more than the contrast of the swing of a limb with its undisturbed quiescence, which is all that movement in vacuo can give us.

In the next place, when the hand is moved over a surface, touching it the while, the feeling of continuance of movement is accompanied by a feeling of continuance of tactile sensation, making the consciousness more marked and acute, and so enabling us to estimate the degree of continuance more nicely. A feeling of the subject (touch proper) is supperadded to the great object sensibility (expended energy as movement), and deepens the impress of that sensibility, without being able to take its place or to constitute the feeling of objectivity. The peculiar tactile sensation that friction causes, is thus a means of suggesting extension and of estimating it, although incompetent to supply the notion itself.

In the third place, movement in vacuo seems unable to indicate that distinction between succession and co-existence —time and space—which must be arrived at before we can say that we recognise Extension. The continuance of movement is a fact that we are conscious of; in other words, we are conscious of a peculiar mode of the putting forth of energy which varies in degree, and we remark one movement as different from another on this point. But if any property of *things* is indicated by this, it would seem to be not space, but time. In truth, neither is known, for they are a correlative couple, not known at all till they are known together.

Now, we are able to show how the embodying of our movements in sensation, enables us to distinguish between the two facts or properties, called the co-existing and the successive.

When, with the hand, we grasp something moving, and move with it, we have a sensation of one unchanged contact and pressure, and the sensation is embedded in a movement. This is one experience. When we move the hand over a fixed surface, we have, with the feelings of movement, a *succession* of feelings of touch; if the surface is a variable one, the sensations are constantly changing, so that we can be under no mistake as to our passing through a series of tactile impressions. This is another experience, and differs from the first, not in the sense of power, but in the tactile accompaniment. The difference, however, is of vital importance. In the one case we have an object moving, and measuring time or continuance; in the other case, we have co-existence in space. The co-existence is still farther made apparent by our reversing the movement, and thereby encountering the tactile series in the inverse order. Moreover, the serial order is unchanged by the rapidity of our own movements. A more rapid pass of the hand makes the series come up quicker; a less rapid, brings the same series in more slowly. By these experiences, we gradually become aware of a wide distinction between identical movements conducted under such different circumstances; and the distinction is expressive in language, as succession and co-existence—time and space. Succession is the simplest fact; an unvarying contact accompanied with a movement, is enough for that. But co-existence is highly complex. The chief points involved in it are those now mentioned; a series of contacts, and the inversion of the series by an inverted movement. The repetition of these with the same mental effects, constitutes that notion of permanence or of fixity of arrangements implied in the object world, the universe as co-existing in space.*

By drawing the hand over a surface, as, for example, twelve inches of wire, we have an impression of the quality of the surface, and also of its length. Transferring the hand

* Mr. Herbert Spencer has analysed the relation of co-existence and sequence with great clearness and felicity. He remarks:—'It is the peculiarity alike of every tactual and visual series which enters into the genesis of these ideas, that not only does it admit of being transformed into a composite state, in which the successive positions become simultaneous positions, but it admits of being reversed. The chain of states of consciousness, A to Z, pro-

to another wire thirty-six inches long, the increased sweep necessary to reach the extremity, is the feeling and the measure of the increased extent. By practising the arm upon this last wire, we should at last have a fixed impression of the sweep necessary for a yard of length, so that we could say of any extended thing, whether it was within or beyond this standard. Nay more, whenever anything brought up a yard to our recollection, the material of the recollection would be an arm impression, just as the material of the recollection of greenness is a visual impression.

If we pass from mere length to some area, as, for example, the *surface* of a pane of glass, we have only a greater complexity of movement and of the corresponding impression. Moving in one direction we get the length, in the cross direction we bring other muscles into play, and get an impression of movement on a different portion of the moving system. In this way we should have the impression of a right angle, or a builder's square. The full impression of the pane of glass would arise through movements from side to side over its whole length, or from movements round the edge and several times across, such as to leave behind the sense of a possibility of finding contact anywhere within certain limits of length and breadth. In this embodiment, and in no other that I know of, would an extended surface be conceived by the mind through muscularity and touch. (The action of vision will be afterwards discussed.)

A cubical block, exemplifying all the three dimensions of *solidity*, presents nothing radically new. A new direction is given to the hand, and a new class of muscles are brought to contribute to the feeling. The movement must now be over

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duced by the motion of a limb, or of something over the skin, or of the eye along the outline of an object, may with equal facility be gone through from Z to A. Unlike those states of consciousness constituting our perception of sequence, which do not admit of an unresisted change in their order, those which constitute our perception of co-existence admit of their order being inverted—occur as readily in one direction as the other.'—*Principles of Psychology*, p. 304.

the length, over the breadth, and over the thickness, and the resulting impression will be a complication of the three movements. To get a hold of the entire solidity, it is necessary to embrace all the surfaces one after another, which makes the operation longer, and the notion more complex and more difficult to retain. But the resulting impression, fixed by being repeated, is of the same essential nature as the notion of a line or a superficies ; it is the possibility, the potentiality, of finding surface in three different directions within given limits. A cubical block of one foot in the side means that, commencing at an angle, and going along one edge, a foot range may be gone over before the material ceases; that the same may then be done across, and also downwards ; and that, between every two edges, there is an extended resisting surface.

The multiplying of points of contact, by our having a plurality of fingers, very much shortens the process of acquiring notions of surface and solidity. In fact we can by means of this plurality measure a length without any movement ; the degree of separation of the fingers, made sensible by the tension of their muscles, being enough. Thus I can appreciate a distance of six or eight inches by stretching the thumb away from the fingers, as in the *span* of the hand. By keeping the fingers expanded in this way so as to embrace the breadth of an object, and then drawing the hand along the length, I can appreciate a surface by a single motion combined with this fixed span of the thumb and fingers. I may go even farther ; by bringing the flexibility of the thumb into action, I can keep the fingers on one surface and move the thumb over another side, so as to have a single impression corresponding to solidity, or to three dimensions. We are, therefore, not confined to one form of acquiring the notion, or to one way of embodying it in the recollection ; we have many forms, which we come to know are equivalent and convertible, so that where we find one, we can expect another. But the most perfect combination of perceiving organs is the embrace of the two hands. The concurrence of the impressions flowing from the two sides of the body, produces a remarkably strong impression of the solidity of a solid object. The two separate, and yet coinciding, images support one another, and fuse together in such a way as make the most vivid notion of solidity that we are able to acquire by means of touch. The parallel case of the two eyes is equally striking.

The notion of solidity thus acquired is complex, being obtained through a union of touch and muscularity, and combining perception of surface with perception of extended form. Space, or unoccupied extension, is movement in vacuo, from one fixed point to another; this is considered to mean extension (as opposed to mere sequence in time), by the inverted operation, and by the repetition giving the same contacts. Empty space means the power of movement without contact or resistance, except at the extreme terms. Resistance and empty space are correlatives. In passing from the sense of the resisting to unresisted movement, we make the transition that developes the cognition of body and of space, under the common object property of Extension.

13. *Distance, direction,* and *situation,* when estimated by touch, involve, in the very same manner, the active organs; the tactile sensations merely furnishing marks and starting-points like the arrows between the chain-lengths in land-measuring. *Distance* implies two fixed points, which the touch can ascertain and identify; the actual measurement is by means of the sweep of the hand, arm, or body from the one to the other. *Direction* implies a standard of reference; some given movement must fix a standard direction, and movement to or from that will ascertain any other. Our own body is the most natural starting point in counting direction; from it we measure right and left, back and fore. For the up and down direction we have a very impressive lead, this being the direction of gravity. When we support a weight we are drawn downward; when not sustaining the arms by voluntary effort, they sink downward; when our support gives way, the whole body moves downward. Hence we soon gain an impression of the downward movement, and learn to recognise and distinguish this from all others. If a blind man is groping at a

pillar he identifies the direction it gives to his hand, as the falling or the rising direction. Circumstances do not, perhaps, so strongly conspire to impress the standard directions of right and left, but there is an abundant facility in acquiring them too. The right deltoid muscle is the one chiefly concerned in drawing the right arm away from the body, and without our knowing anything about this muscle, we yet come to associate the feeling of its contraction with a movement away from the body to the right. All directions that call forth the play of the same muscles, are similar directions as respects the body; different muscles mean different directions. The great pectoral bringing the arm forward, the deltoid lifting it away from the side, the trapezius drawing it backward, indicate to our minds so many different positions of the guiding object; and we do not confound any one with the other. We learn to follow the lead of each one of these indications; to make a forward step succeed the contraction of the pectoral, a step to the right the deltoid, a step backward the trapezius.

Situation, or relative position, is know, if distance and direction are known. The idea of position implies three points. Two points might give extension, but relative position implies that we pass from A to B, from B to C, and from A to C. These movements often repeated in both the direct and in the inverse order, impart the idea of permanent co-existence in relative position, which amounts to an experience of extension. The multiplication of these is the enlargement of our education in the co-existing and extended, from which at last, by an exercise of abstraction, we rise to the notion of space or extension in general.

Form or shape is determined by position. It depends upon the course given to the movements in following the outline of a material body. Thus we acquire a movement corresponding to a straight line, to a ring, an oval, &c. This is purely muscular. The fixed impressions engrained upon the organs, in correspondence with these forms, have a higher interest than mere discrimination. We are called upon to reproduce them in many operations—in writing, drawing, modelling,

&c.—and the facility of doing so will depend, in great part, upon the hold that they have taken upon the muscular and nervous mechanism. The susceptibility and retentiveness of impressions necessary to draw or engrave skilfully, are principally muscular endowments.

14. So much for the qualities revealed to us by touch, either alone or in conjunction with movement. The accompaniment of activity belongs to every one of the senses; it serves to bring about or increase the contact with the objects of the sense. There is in connection with each of the senses a particular verb, or designation, implying action; *to taste* implies the movement for bringing the substance upon the tongue; *to smell*, or to *to snuff*, means an active inhalation of the odorous stream; *to feel* signifies the movement of the hand or other organ over the surface in search of impressions; in like manner, to hear and to see are forms of activity. In the cases of taste and smell, the action does not contribute much to the sensation or the knowledge; in the three others (two especially) it is a material element, since in all of them, direction and distance are essential parts of the information. Now, since movement is required to bring objects within reach, the value of any of our senses will depend very greatly upon the activity of the organs that carry the sensitive surface, the *tentacula*, so to speak. This activity grows out of the muscular and nervous energy of the frame, and not out of the particular endowment of the sensitive part. It is a voluntary exertion, at first spontaneous purely, always spontaneous in some degree, but linked to, and guided by, the sensibility. The flush of activity lodged in the arm and fingers is the first inspiration towards obtaining impressions of touch; the liking or disliking for the impressions themselves, comes in to modify and control the central energy, and to reduce handling to a system.

15. Touch being concerned in innumerable handicraft operations, the improvement of it as a sense enters largely into our useful acquisitions. The graduated application of the force of the hand has to be ruled by touch; as in the potter

with his clay, the turner at his lathe, the polisher of stone, wood, or metal, the drawing of the stitch in sewing, baking, taking up measured quantities of material in the hand. In playing on finger instruments, the piano, guitar, organ, &c., the touch must measure the stroke or pressure that will yield a given effect on the ear.

16. The observations made on persons born blind have furnished a means of judging how far touch can substitute sight, both in mechanical and in intellectual operations. These observations have shown, that there is nothing essential to the highest intellectual processes of science and thought, that may not be attained in the absence of sight. The integrity of the moving apparatus of the frame renders it possible to acquire the fundamental notions of space, magnitude, figure, force, and movement, and through these to comprehend the great leading facts of creation as taught in mathematical, mechanical, or physical science.

17. The skin is liable to feelings not produced by an external pressure, but resembling what would arise from particular agents, and suggesting them to the mind. These are called 'subjective sensations.' The tingling of a limb asleep, formication, or a sensation as of the creeping of insects, heat, chilliness, &c., are examples.—(TODD and BOWMAN, I. 433.)

SENSE OF HEARING.

This sense is more special and local than the foregoing, but agrees with Touch in being a mechanical sense as distinguished from what I have chosen to consider as the chemical senses—Taste and Smell.

1. The objects of hearing, are material bodies in a state of tremor, or vibration, brought on when they are struck, which vibration is communicated to the air of the atmosphere, and is thereby propagated till it reach the hollow of the ear.

All bodies whatever are liable to the state of sonorous vibration; but they differ very much in the degree and kind of it. The metals are the most powerful sources of sounds, as we see in bells; after these come woods, stones, earthy bodies. A hard and elastic texture is the property needed. Liquids and gases sound very little, unless impinged by solids. The howling and rustling of the wind arise from its playing upon the earth's surface, as on the Æolian harp. The thunder is an example of a pure aerial sound, the effect, great as it is, being very small in comparison to the mass of air put in agitation.

It belongs to the science of Acoustics to explain the production and propagation of sound, and the forms of sounding instruments of all kinds. Here we are considering the effects, and not the instruments of sound. Even the human voice, whose description cannot be omitted in a treatise on mind, will come in under another head.

2. The *organ* is the Ear. 'It is divisible into three parts the external ear, the tympanum or middle ear, and the labyrinth or internal ear; and of these the first two are to be considered as accessories or appendages to the third, which is the sentient portion of the organ.'

The *external ear* includes 'the pinna—the part of the outer ear which projects from the side of the head—and the meatus or passage which leads thence to the tympanum, and is closed at its inner extremity by the membrane interposed between it and the middle ear (membrana tympani).'

'The *tympanum*, or drum, the middle chamber of the ear, is a narrow irregular cavity in the substance of the temporal bone, placed between the inner end of the external auditory canal and the labyrinth. It receives the atmospheric air from the pharynx through the Eustachian tube, and contains a chain of small bones, by means of which the vibrations, communicated at the bottom of the external meatus to the membrana tympani, are conveyed across the cavity to the internal ear, the sentient part of the organ. The tympanum contains likewise minute muscles and ligaments which belong to the bones referred to, as well as some nerves which end within this cavity, or only pass through it to other parts.'

As to the cavity of the tympanum, I shall content myself with quoting the description of the anterior and posterior boundaries, whereby it connects itself with the outer and inner portions of the ear, and which are therefore the main links in the line of communication from without inwards.

The outer boundary, formed by a thin semi-transparent membrane, the membrana tympani, which may be seen by looking into the ear, 'is nearly circular, and is slightly concave on the outer surface. It is inserted into a groove at the end of the passage of the outer ear, and so obliquely that the membrane inclines towards the anterior and lower part of the canal at an angle of 45°. The handle of one of the small bones of the tympanum, the malleus, descends between the middle and inner layers of the membrane to a little below its centre, and is firmly fixed to it; and as the direction of the handle of the bone is slightly inwards, the outer surface of the membrane is thereby rendered concave.'

The *inner wall* of the tympanum, which is formed by the outer surface of the internal ear, is very uneven, presenting several elevations and foramina. The foramina or openings are two in number, the oval foramen (fenestra ovalis) and the round or triangular opening (fenestra rotunda). Both are closed with membranes, which render the inner ear, with its containing liquid, perfectly tight. To one of them, the oval foramen, a small bone is attached, the other the round foramen, has no attachment. These two openings are the approaches to the internal ear, and through them lies the course of the sonorous vibrations in their progress towards the auditory nerve.

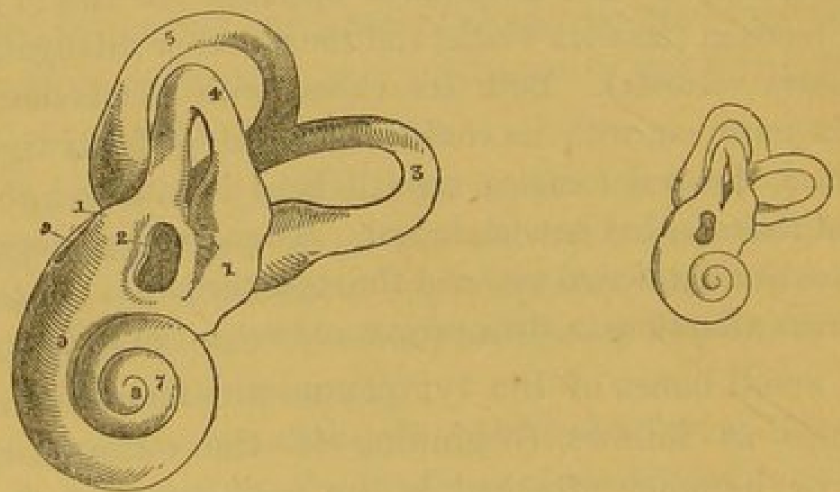
The small bones of the tympanum are named from their appearance as follows (beginning at the outermost): the *malleus,* or hammer, attached to the membrane of the tympanum; the *incus,* or anvil; and the *stapes,* or stirrup, which is fixed to the oval opening in the inner ear, called the *fenestra ovalis.* The incus is thus intermediate between the other two, and the result of the whole is, 'a species of angular and jointed connecting rod between the outer and inner walls of the tympanic cavity, which serves to communicate vibrations from the membrana tympani to the fluid contained in the vestibule of the internal ear.'

There are certain small muscles attached to those bones for the regulation of their movements. On the number of these muscles Anatomists are not agreed, owing to the minuteness and ambiguous appearance of the fibres. As to one of them there is no dispute, namely, the *tensor tympani*, a muscle inserted into the handle of the malleus, and by its contraction drawing inwards and tightening the membrane of the tympanum. A second muscle, admitted by most anatomists, is that named the *stapedius*, from its attachment to the stapes, or stirrup-bone, at the other end of the chain from the malleus. Mr Toynbee considers the action of these two muscles as antagonistic.

The *internal ear*, or *labyrinth*, 'which is the essential or sensory part of the organ of hearing, is contained in the petrous portion of the temporal bone. It is made up of two very different structures, known respectively as the osseous and membranous labyrinth.'

1. 'The *osseous labyrinth* is lodged in the cancellated structure of the temporal bone, and presents, when separated from this, the

Fig. 7.*



appearance shown in the enlarged figure. It is incompletely divided into three parts, named respectively the vestibule, the semicircular canals, and the cochlea. They are lined throughout by a thin serous membrane, which secretes a clear fluid.

'(2.) The *membranous labyrinth* is contained within the bony labryinth, and, being smaller than it, a space intervenes between the

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* 'An enlarged view of the labyrinth from the outer side :—1. Vestibule. 2. Fenestra ovalis. 3. Superior semicircular canal. 4. External semicircular canal. 5. Posterior semicircular canal. 6. First turn of the cochlea. 7. Second turn. 8. Apex of Colchlea. 9. Fenestra rotunda. * Ampullæ of semicircular canal.—The smaller figure represents the osseous labyrinth of the natural size.'—(Quain).

two, which is occupied with the clear fluid just referred to. This structure supports the numerous minute ramifications of the auditory nerve, and encloses a liquid secretion.'

The minute anatomy of these parts I must pass over. The *vestibule* is the central chamber of the mass, and is the portion of the labyrinth turned towards the tympanum, and containing the cavities of communication above described. The *semicircular canals* are three bony tubes, situated above and behind the vestibule, into which they open by five apertures; each tube being bent so as to form the greater part of a circle. The *cochlea* is a blunt cone, having its surface 'marked by a spiral groove, which gives to this part of the labyrinth somewhat of the appearance of a spiral shell—whence its name.' Its interior is a spiral canal divided into two by a thin partition, deficient at the apex of the cochlea. The canal opens freely into the cavity of the vestibule.

'Within the osseous labyrinth, and separated from its lining membrane by a liquid secretion, is a membranous structure, which serves to support the ultimate ramifications of the auditory nerve. In the vestibule and semicircular canals this membrane has the form of a rather complex sac, and encloses a fluid called the endolymph; in the cochlea the analogous structure merely completes the lamina spiralis (the partition of the cochlea), and is covered by the membrane which lines the general cavity of the osseous labyrinth.'

The labyrinth is thus to be considered as a complicated chamber full of liquid, and containing also a membranous expansion for the distribution of the nerve of hearing. Let us next advert to the *action* of these different parts in producing the sensations of sound.

3. The waves of sound enter the passage of the outer ear, and strike the membrane of the tympanum. The structure of the outer ear is adapted to collect and concentrate the vibrations like an ear trumpet. The form of the shell gives it a reflecting surface for directing the sound inwards; while the passage is believed to increase their intensity by resonance. Reaching the membrane of the tympanum, the beats communicate themselves to its surface and set it vibrating, which

is done all the more easily that the membrane is very thin and light in its structure. Experiments have shown, that the only means of receiving with effect the vibrations of the air, is to provide a thin stretched membrane of this nature. The vibrations of the membrane are communicated to the chain of small bones traversing the middle ear, and connected through the oval foramen with the enclosed liquid of the inner ear. By this means a series of beats are imparted to the liquid, which diffuse themselves in waves all through the passages of the labyrinth, and operate by compressing the membranous labyrinth, and through it the imbedded fibres of the auditory nerve, which compressions are the immediate antecedent of the sensation of hearing. The character of the sensation will of course vary with the character of the waves, according as they are violent or feeble, quick or slow, simple or complex, and so forth.

There is little difference of opinion as to the general course of the action now described. The transitions have all been imitated by experiments, and it has been found that the arrangement is a good one for bringing about the ultimate effect, namely, the gentle compression of the filaments of the nerve of hearing. No other medium could serve the final contact so well as a liquid, but in order to impress the liquid itself, an intermediate apparatus between it and the air is requisite. This intermediate apparatus is solid, and composed of two parts, the first slender and expanded, so as to be susceptible to the beats of the air, the second dense and contracted (the chain of bones), to produce a sufficiently powerful undulation in the liquid. The membrane once affected is able to communicate vibrations to the bones, and the last of the chain, the stapes, is able to impress the labyrinthine fluid. So far the process has been rendered sufficiently intelligible.

The vibrations of the ear can reach the nerve of hearing otherwise than along the main passage, and through the medium of the tympanum. The bony integuments of the head generally can serve as conductors, and this, not only when the impulse is from the first communicated to a hard substance like the teeth, but even when the waves of sound first strike external soft parts. In the last case, however, the sound must have a very considerable intensity, whereas no great intensity is required for the passage by the teeth.

The separate functions of the different parts of the inner ear are not understood. In the cochlea (the most important part), the membrane wherein the nerve is spread takes on peculiar tooth-shaped forms, and also contains elastic films or laminæ. The length of each lamina is about $\frac{1}{750}$ of an inch, and their thickness $\frac{1}{12500}$ of an inch. The laminæ lie upon the ends of the tooth-shaped forms, and are arranged like the keys of a piano and closely packed together. Wundt believes that different tones affect different parts of the nerve of hearing, and that as elastic bodies are adapted for some particular tone, and remain quiet when other tones are sounded, so these elastic laminæ are divided into groups for separate notes, and excite the connected nerve fibres accordingly.

It would be interesting to ascertain the precise uses of the muscles of the ear. There are three that have received names: the *tensor tympani*, whose purpose undoubtedly is, as the name signifies, to tighten the membrane of the tympanum; the *stapedius* inserted into the stirrup bone, and considered by Mr. Toynbee to be antagonistic to the other; and the *laxator tympani minor*, inserted into the handle of the malleus, whose action cannot be guessed with any probability.

It has not been well ascertained on what occasions and with what effect the tensor tympani is brought into play. The only distinct observation on the matter is that made by Dr. Wollaston, namely, that when the membrane of the tympanum is stretched, the ear is rendered less sensible to grave sounds, such as the deep notes of the organ, or the sounds of thunder and cannon. When therefore the ear is exposed to very intense sounds of the deep kind, such as the firing of artillery, the tensor tympani coming into play would in some measure deaden the effect. The action would make little or no difference to the hearing of acute sounds, such as the sharp notes of a call-whistle. Probably these muscles are excited by the reflex action of the sounds; possibly, also, they may be of the voluntary class, that is, they may come into play in the voluntary acts of listening and of preparing the ear to resist loud sounds. The only circumstance assignable as determining the reflex action of the tensor tympani is simply the intensity of the sound. We may suppose that every sound whatever brings on a reflex action to stretch the membrane, and the stronger the sound the greater the action. When sounds are too loud, and of the grave kind, this tension mitigates them; when too loud and acute, it either has no effect, or makes the evil worse.

'Dr. Wollaston performed many experiments upon the effects of tension of the membrana tympani, and he found that deafness to grave notes was always induced, which, as most ordinary sounds are of a low pitch, is tantamount to a general deafness. Shrill sounds, however, are best heard when the tympanic membrane is tense. Müller remarks, and we have frequently made the same observation, that the dull rumbling sound of carriages passing over a bridge, or of the firing of cannon, or of the beating of drums at a distance, ceases to be heard immediately on the membrana tympani becoming tense; while the treading of horses upon stone pavement, the more shrill creaking of carriages and the rattling of paper, may be distinctly heard.'—TODD and BOWMAN, vol. ii. p. 95.

4. Passing now to Sounds considered as Sensations, I might distinguish these into three classes; the first would comprise the general effects of sound as determined by Quality, Intensity, and Volume or Quantity, to which all ears are sensitive. The second class would include Musical sounds, for which a susceptibility to Pitch is requisite. Lastly, there is the sensibility to the Direction and Articulateness of sounds; on these properties depend much of the intellectual uses of the sense of hearing.

5. *Sweetness.*—Like sweet and bitter in Taste, there is a qualitative distinction of sounds into such as intrinsically possess the power of gratifying the sense of hearing, and those

that give, in an unmingled form, the peculiar pain that we are capable of deriving through this organ. The terms sweet, rich, mellow, are applied to the pleasing effects of pure sound. Instruments and voices are distinguished by the sweetness of their individual tones; there is something in the material and mechanism of an instrument that gives a sweet and rich effect, apart altogether from the music of the airs performed upon it. Other instruments and sounds have a grating, harsh, unpleasant tone, like bitterness in taste, or a stink in the nostrils. Some substances, by their texture, have a greater sweetness of note than others. Thus silver is distinguished among the metals; and glass is also remarkable for pure rich tones. The hard woods are usually better than the soft for the construction of instruments.

This sensation of the sweet in sound I have characterized as the simple, pure, and proper pleasure of hearing; a pleasure of great acuteness but of little massiveness. The acuteness of it is proportioned to the rank of the ear as a sensitive organ, or to the susceptibility of the mind to be stirred and moved through the channel of hearing.

There is however a great superiority in the endurableness of sweet sounds over the sweets of the inferior senses. In Touch this distinction exists in the comparison with Taste and Smell; in Hearing there is a farther progress, and we shall have to note the crowning pitch of this important property when we come to the sense of Sight. By virtue of this fact we can obtain from sight and hearing a larger amount of enjoyment within the same degree of fatigue or exhaustion, or before reaching the point of satiety. Hence one reason for terming these the 'higher senses.'

I may remark that great sweetness of tone is not a usual property of the sounds about us, nor are we often exposed to very harsh or repulsive effects on the ear.

As regards persistence in the intellect, there is a common superiority in sounds in general over Tastes and Smells, which will be alluded to at the close of our remarks upon the sense of hearing. By virtue of that character, the pleasure of sound is more extended in its influence over our mental life, by being more realizable in idea, than the pleasures of these other senses.

6. *Intensity, Loudness.*—Sounds may be either faint or loud, and as such they affect the ear differently. A faint gentle sound, otherwise not disagreeable, is a source of pleasurable stimulus to the ear. The tone of a steady breeze, the distant hum of a city, the rush of a rivulet, are instances of gentle sounds yielding pleasure to the ear disposed to listen to them.

When the sound passes from the gentle to the loud, we have as a matter of course a more intense stimulus. The sensation then becomes keen and pungent, like the action of ammonia on the nose, or a smart stroke on the skin. A loud speaker is exciting. The rattle of carriages, the jingle of an iron work, the noise of a cotton mill, the ringing of bells close to the ear, the discharge of ordnance, are all exciting from their intensity; to fresh and vigorous nerves plunged into them after quietness, these noises are an intense pleasure. They may be described, however, as a *coarse* excitement; there is a great cost of tear and wear of nerve for the actual satisfaction.

The intensity, rising beyond a certain pitch, turns to pain. The screeching of a parrot-house, the shrill barking of the smaller species of dogs, the whistling in the fingers practised by boys in the streets, the screaming of infants, are instances of painful pungency. It is in pain that the delicacy of the ear makes itself most apparent; the annoyance of a fatigued and jaded ear is very difficult to overcome, and the agony of acute suffering arising from sounds, in certain disorders of the ear, is known to be of the most unendurable kind.

The *suddenness* of sounds is a feature allied with intensity, and marks a contrast between two successive states of nerve, one little excited, and the other much. In producing anger, terror, and mental discomposure, a sudden sound is very effective; in this resembling an unexpected shock or check to the movements of the body.

7. *Volume* or *Quantity.*—This means the sound coming

from a sounding mass of great surface or extent. The waves of the 'many sounding sea,' the thundery discharge, the howling winds, are voluminous sounds. A sound echoed from many sides is made voluminous. The shouts of a great multitude is a powerful instance of the voluminous. Grave sounds, inasmuch as they require a larger instrument, are comparatively voluminous.

This multiplication of sounds, without increase of individual intensity, has a very agreeable effect upon the ear. The stimulus is greatly increased, but not fatiguingly so. The sensation is extended in volume or amount without becoming pungent; like the difference between a warm bath and the immersion of the feet in tepid water. Apart from music, perhaps the greatest pleasure that sound can give is derived from voluminous effects.

8. *Pitch*, or *Tune*.—This is the musical character of sounds. By it is meant the acuteness or graveness of the sound, as determined by the ear, and this is found to depend on the rapidity of vibration of the sounding body, or the number of vibrations performed in a given time. Most ears can mark a difference between two sounds differing in acuteness or pitch: those that cannot do so to a minute degree are incapable of music. The gravest sound audible to the human ear is stated by the generality of experimenters at 20 vibrations per second; the limit of acuteness is various for different individuals, the highest estimate is 73,000 vibrations in the second. The cry of a bat is so acute as to pass out of the hearing of many persons. The extreme audible range would amount to between nine and ten octaves.

Although in music no less intervals than a semitone are admitted, the ear can distinguish still smaller differences. A quarter of a tone makes a marked difference to an ordinary ear. A good musician can distinguish two tones whose vibrations are as 1149 to 1145, sounded after each other, and even a smaller difference if they are sounded together. Two pitchforks whose number of vibrations per second are 1209 and 1210, sounded simultaneously, can be distinguished by a first-rate ear.

An ear sensible to pitch is also sensible to the difference between a musical sound and a noise. A musical note is in itself a harmony; being the equal timing of successive vibrations or pulses. It is, in a minute or microscopical subdivision, the same effect as equality of intervals or time in a musical performance; although the one may be a thousand beats per second, the other not more than two in the same time. It is an acute sensation of pleasure, more refined and exquisite than mere pungency, or the effect of loudness; and is the foundation of the musical art.

9. The *waxing* and *waning* of sound. The gradual increase or diminution of the *loudness* of a sound, is one of the effects introduced into musical composition, owing to the power it has to impart additional pleasure. The howling of the wind has sometimes this character, and produces a deep impression upon all minds sensitive of sound. The dying away of sound is perhaps the more exciting of the two effects; 'that music hath a dying fall.' It may be, that a muscular effect enters into this sensation: the gradually increased or relaxed tension of the muscles of the ear being a probable accompaniment of the increase or diminution of loudness. On this supposition, the influence on the mind would be a feeling of movement. But we cannot certainly affirm, that the effect may not arise through the auditory nerves alone. The moaning of the wind is due to the waxing and waning of the intensity of the sound. When the *pitch* is gradually changed, as well as the degree, we have a farther effect, introduced into musical composition, but apt to degenerate into the 'whine' or 'sing-song,' a somewhat coarse effect, both in music and in speech. In the notes of birds we may trace this effect; in the execution of accomplished singers, in the violin and other instruments, and in the cadences of a musical orator, we may likewise observe it; in all cases telling powerfully.

10. *Complexity* is a character of sounds, yielding peculiar sensations of various kinds. The sounds concurring on the ear at the same moment may be many or few. The membrane of the tympanum may be affected by several series of undula-

tions, which will be transmitted with all their primitive distinctness to the fibres of the nerve of hearing. But in the consciousness the distinctness is not well preserved ; some degree of fusion takes place ; and this may be grateful or otherwise according to the nature of the separate sounds. Sometimes a multitude of sounds falling upon the ear together, are perfectly indifferent to one another, as in the ordinary din of a market-place, or a crowded city. At other times a painful action ensues from the confluence of sounds, as in the jarring sounds of an instrument out of tune. This we call a *discord.* The effect is a feeling of acute pain, intense in proportion to the musical sensibility of the ear.

The opposite of discord is *harmony,* or the combination aimed at in music. The sounds that harmonise are well known to be related to one another numerically in the number of their vibrations. The mental effects of harmonies belong to the Emotions of Fine Art.

11. *Clearness,* or purity.—A clear sound is one that has a distinct, uniform character, and is not choked or encumbered with confusing ingredients. Clearness is a property that affects both the preception of meaning and the pleasure of music. A clear-toned instrument is one that yields, unmixed and in perfection, the notes that the performer aims at producing. The perception of tone or pitch must needs depend much on the clearness of the sound. In instruments, the purity varies with the substance. Silver, among the metals, is clear-toned. Glass, from the uniformity of its texture, is noted for its quality. It is a suggestive circumstance, that these are the materials yielding the sweetest tones. In instruments of wood, a hard and uniform tissue is indispensable. In the human voice *musical* clearness and *articulate* clearness depend upon different qualities. The first arises from the structure of the larynx and the molecular nature of the resonant skull ; the second depends upon the sharpness and suddenness of the articulate actions of the mouth. In every kind of expression clearness is a cardinal virtue ; the merit of musical or articulate performances must rise or fall, according as the effect intended stands out apart from other effects not intended.

12. *Timbre, Complexion,* or *Quality.* This means the difference between the same note sounded on different instruments or voices. We recognise a qualitative difference between the flute and the violin, or between the trumpet and the clarionet; and we can distinguish one violin from another, and one voice from another. The ring of a sovereign or of a shilling is a criterion of the genuineness of the coin.

This distinction between different sounding materials, instruments, and voices, is now referred to the co-existence in each of upper tones, with the principal tone or note of the instrument; the nature of these upper tones being not the same in all instruments and voices. It has long been known that when a string is sounded, it vibrates not only in its whole length, giving the note corresponding to its length, but also in halves and quarters, yielding notes an octave and two octaves above the primary. These are the upper tones, which mix themselves with the principal note, or the ground tone. There are tones, in some instruments, as the organ, that are almost entirely devoid of accompanying upper tones; these would exemplify pure sounds. But in the common wind instruments, in stringed instruments, and in the human voice, the number of accompanying upper tones is great and various. The timbre, or quality, of the instrument depends partly on the strength of these upper tones, and partly on the kind of tones that are sounded with peculiar intensity.

If the accompanying tones become very prominent, the ground tone is confused and overlaid, so that we cease to hear a distinct musical note. At this point the sound passes into mere noise.

13. *Direction.*—This is a purely intellectual sensation, in other words, is of importance as leading us to perceive the situation of the objects of the outer world whence the sound takes its rise.

The following extract from Longet indicates the kind of experience that gives us the feeling of direction:—

'With regard to the direction of the sonorous waves we can at present only say, that the knowledge of it is owing to a process of reasoning applied to the sensation. Thus, we hear distinctly a sound emanating from a given point, whatever be the position of the head; but the ear being able to judge of slight differences in the intensity of sounds, we remark that, in certain positions of the head, the sound seems stronger. We are hence led to place our head in one fixed position as regards the sounding body. But our sight tells what is this direction of most perfect hearing; and we then apply the observation made on bodies that we can see to those that are not seen.'

The combined action of the two ears undoubtedly favours the perception of direction of sound very materially. A person who has lost the hearing on one side, is usually unable to say whether a sound is before or behind. The change of effect produced by a slight rotation of the head, is such as to indicate direction to the mind. For while the sound becomes more perceptible on one ear,—the ear turned to face the object more directly,—the sound in the other ear is to the same degree obscured. When the head is so placed, after various trials, that the greatest force of sensation is felt on the right ear, and the least on the left, we then infer that the sounding body is away to the right; when the two effects are equal, and when any movement of the head makes them unequal, we judge the sound to be either right in front or behind; and we can further discriminate so as to determine between these two suppositions.*

The sense of direction is by no means very delicate, even after being educated to the full. We can readily judge whether a voice be before or behind, right or left, up or down; but if we were to stand opposite to a row of persons, at a distance, say, of ten feet, we should not be able, I apprehend, to say which one emitted a sound. This confusion is well known to schoolmasters. So it is next to impossible to find out a skylark in the air from the sound of its song.

* According to Ed. Weber, in determining the direction of sounds, we employ the external ear for those coming from above, below, behind, before;

We are apt to mix inferential processes with our judgment of distance. If we are led to imagine that a sound is farther off than it really is, we seem to hear it stronger than it is. Awaking suddenly in the night, we hear a faint noise, and suppose it much louder, our notion of its real distance being for a few moments vague and confused. It being an effect of distance that sounds fade away into a feeble hum, when we encounter a sound whose natural quality is feeble, like the humming of the bee, we are ready to imagine it more distant than the reality.

14. The perception of *distance* can result from nothing but experience. I quote again from Longet. 'As soon as the organ presents a sensibility and a development sufficient for discerning easily the relative intensity of two consecutive sounds, nothing farther is necessary in order to acquire the notions of distance and direction of the body from which the sonorous waves emanate. In fact, if a sound is already known to us, as in the case of the human voice, or an instrument, we judge of its distance by the feebleness of its impression upon the nerve of hearing; if the sound is one whose intensity, at a given distance, is unknown, as, for example, thunder, we suppose it nearer according as it is louder.'

15. *Articulate sounds.*—Of articulate sounds, some have a character so peculiar that our discrimination of them is no surprise. The hissing sound of *s*, the burring of the *r*, the hum

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the tympanum for those coming from left and right. He made the following experiments :—The head was inserted in water, the air-passage being filled with air, so that the tympanum was free to vibrate. In that case, the ear recognized the sounds as external to itself, but could distinguish them only as right or left in direction. When, farther, the ear itself was filled with water, and the free action of the tympanum arrested, the sense of externality altogether was lost. The feelings were regarded as subjective. It was observed by E. H. Weber that the uniting of the double sensation from the two ears (analogous to binocular vision) has its limits. If two watches with different rates of ticking are held before one ear, the ear distinguishes the periods when the strokes of the two fall together, and forms to itself a rhythm out of the two series of strokes. If the watches are applied, one to each ear, the sense of rhythm is lost. The mind can no longer make the combination effected when the two watches were applied separately to the two ears.

of the *m*, are well marked modes of producing variety of effect. We can understand how each should impart a different kind of shock to the nerve of hearing. So we can see a reason for distinguishing the abrupt sounds *p*, *t*, *k* from the continuous or vocal sounds *b*, *d*, and *g*, and from the same sounds with the nasal accompaniment *m*, *n*, *ng*. It is not quite so easy to explain the distinction of shock between the labials, dentals, and gutturals; still, if we compare *p* (labial), with *k* (guttural), we can suppose that the stroke that gives the *k* is harder than the other.

Much greater difficulty attaches to the vowel sounds, which differ only in the mode of opening the mouth, while the sound is emitted. The explanation given is the same as for the timbre of sounds. Helmholtz, to whose investigations the theory of upper tones is due, lays it down, as the result of numerous experiments, that vowel sounds contain, besides the ground-tone, a number of upper-tones, or by-tones, with double, triple, &c. the number of vibrations of the ground-tone, and are distinguished, or have their peculiar character, from the nature of those accompaniments. Willis and Cagniard-Latour contrived modes of producing vowel sounds artificially; and Helmholtz, by making specific combinations of various simple tones, imitated all the vowel articulations.

When the ground-tone is heard alone, the sound has the character of *u* (full). The *o* has, along with the ground-tone, the next octave audibly combined. The *a* (ah) is characterized by the marked presence of the very high octaves..*

* The following is Helmholtz's table for the leading vowel sounds:—

Vowel.	Ground-Tone.	2nd.	3rd.	4th.	5th.	6th.	7th.
u (full)	strong	—	weak	—	—	—	—
o (oh)	strong	strong	(weak)	(weak)	—	—	—
e (get)	strong	middling	strong	(weak)	(weak)	—	—
i (bit)	weaker	strong	(very weak)	strong	(middling)		
a (ah)	strong	(weak)	weak	middling	stronger	stronger	stronger

$\underbrace{\text{stronger stronger stronger}}_{\text{than 3 and 4.}}$

The parentheses denote that the tones they inclose are not absolutely necessary to the making of the special vowel-sound.

The same principle is applied to explain differences in the consonant sounds ; but as respects these, there are other palpable distinctions such as we have alluded to above.

Some persons are distinguished by their nice discrimination of articulate sounds. If the foregoing theory be correct, a good ear for musical notes should be also a good ear for articulation, seeing that the articulate sounds involve composite musical tones. An ear for pitch is thus the basis both of music and of speech. The sense of Time is not confined to any organ or any class of feelings ; but it may attain to great perfection in hearing.

As a general rule, the emotional sensibility of any sense bears no fixed relation to the intellectual sensibility. An ear may be very inflammable to exciting effects of sound, and may, at the same time, be very dull to all those differences of quality and of degree that constitute the meaning of sounds, as well as their delicate harmonies. It is like the difference to the eye between a bonfire and a landscape, between the glare of noon and an algebraical formula.

16. The duration of an impression of sound can be appreciated by noting at what intervals a succession of beats seems an uninterrupted stream of sound. This makes, in fact, the inferior limit of the audibility of sounds. From the experiments of Savart, it would appear that a series of beats begins to be felt as continuous when they number from ten to twelve in a second ; so that the impression of each must continue not less than the tenth part of a second.

SENSE OF SIGHT.

1. The *objects* of sight include nearly all material bodies. Their visibility depends on their being acted on by Light, the most inscrutable of natural agents. Certain bodies, such as the Sun, the Stars, flame, solids at a high temperature, give origin to rays of light, and are called self-luminous. Other bodies, as the Moon, the Planets, and the greater number of terrestrial surfaces, are visible only by reflecting the rays they receive from the self-luminous class.

The reflection of light is of two sorts: mirror reflection, which merely reveals the body that the light comes from; and reflection of visibility, which pictures the reflecting surface. In this last mode of reflection, the light is broken up and emitted in all directions exactly as from a self-luminous original. Visible surfaces receiving light from the sun have thus the power of absorbing and re-issuing it, while a mirror simply gives a new direction to the rays. When we look at a picture in a bad light, we find that the rays of reflection overpower the rays arising from the coloured surface of the picture, and consequently the picture is imperfectly seen.

As regards vision, bodies are either opaque or transparent. There is a scale of degrees from the most perfect opacity, as in a piece of clay, to the most perfect transparency, as in air. According as bodies become transparent, they cease to be visible.

The transparency of air is not absolutely perfect; that is to say, light in passing through the atmosphere is to a certain small extent arrested, and a portion reflected, so as to make the mass faintly visible to the eye. When we look up into the sky through a cloudless atmosphere, all the illumination received from the surface is light reflected by the atmosphere itself. Liquids are still less transparent; although they transmit light so as to show objects beyond them, they also reflect a sufficient portion to be themselves visible. Light falling upon the surface of water is dealt with in three different ways. One portion passes through, a second is reflected as from a mirror, a third very small portion is absorbed and radiated anew, so as to make the surface visible as a surface. The same threefold action obtains in transparent solids, as glass, crystal, &c. It is to be remarked of solid bodies that they are almost all transparent to a certain small depth, as shown by holding up their plates or laminæ to the light. Gold leaf, for example, permits the passage of light; and any other metal, if similarly attenuated, would show the same effect. There is, however, in this case, an important difference to be noted, inasmuch as objects are not distinctly seen, although light is transmitted; hence the name 'translucent' is applied to the case to distinguish it from proper transparency. There may be something more than a difference of degree between the two actions.

Opaque bodies may diffuse much light or little: some substances, such as chalk and sea foam, emit a large body of light; charcoal is remarkable for absorbing without re-emission the sun's rays. This is the ordinary, perhaps not the full, explanation of white and black, the one implying a surface which emits a large portion of the rays of visibility, the other few or none.

Besides that difference of action which makes white and black, and the intermediate shades of grey, there is a difference in the texture of surfaces, giving birth to what we recognise as colour. Upon what peculiarity of surface the difference between, for example, red and blue, depends, we cannot at present explain. But this fact of colour is one among the many distinctions presented by the various materials of the globe. Along with colour a substance may have more or less of the property that decides between white and black, namely, copiousness of radiation. This makes richness of colour, as in the difference between new and faded colours, between turkey red and dull brick clay of a similar hue.

Bodies that are translucent to a certain depth have from that circumstance a distinct appearance, named their lustre The effect of this property on the sense, I shall discuss when we come to the Sensations of Sight.

Mineral bodies present all varieties of light, colour, and lustre, but the prevailing tint of rocks and soils is some shade of grey. The reddish tint of clays and sandstones is chiefly due to the prevalence of oxide of iron. Vegetation yields the greenness of the leaf, and the variegated tints of the flower. Animal bodies present new and distinct varieties.

2. We come next to consider the *organ* of sight, the Eye.

'Besides the structures which compose the globe of the eye, and constitute it an optical instrument, there are certain external accessory parts, which protect that organ, and are intimately connected with the proper performance of its functions. These are known as the appendages of the eye,' (they have been named likewise tutamina oculi) ; and they include the eyebrows, the eyelids, the organ for secreting the sebaceous (or oily) matter, and the tears, together with the canals by which the latter fluid is conveyed to the nose.'

'The eyebrows are arched ridges, surmounting on each side the upper border of the orbit, and forming a boundary between the forehead and the upper eyelid. They consist of thick integument, studded with stiff, obliquely set hairs, under which lies some fat, with part of the two muscles named respectively the orbicular muscle of the eyelids and the corrugator of the eyebrows.' By this last-named muscle the eyebrows are drawn together, and at the same time downwards, so as to give the frowning appearance of the eye ; the opposite action of lifting and separating the eyebrows is performed by a muscle lying beneath the skin of the head termed the occipito-frontalis. In regulating the admission of light to the eye, and in the expression of the passions, these two muscles are called into play ; the one is stimulated in various forms of pain and displeasure, the other in an opposite class of feelings.

'The *eyelids* are two thin moveable folds placed in front of each eye, and calculated to conceal it, or leave it exposed, as occasion may require. The upper lid is larger and more moveable than the lower, and has a muscle (levator palpebræ superioris) exclusively intended for its elevation. Descending below the middle of the eye, the upper lid covers the transparent part of the organ ; and the eye is opened, or rather the lids are separated, by the elevation of the upper one under the influence of the muscle referred to. The eyelids are joined at the outer and inner angles of the eye ; the interval between the angles varies in length in different persons, and, according to its extent, (the size of the globe being nearly the same,) gives the appearance of a larger or a smaller eye. At the outer angle, which is more acute than the inner, the lids are in close contact with the eyeball ; but at the inner angle, the caruncula lachrymalis (a small red conical body) intervenes. The free margins of the lids are straight, so that they leave between them, when approximated, merely a transverse chink. The greater part of the edge is flattened, but towards the inner angle it is rounded off for a short space ; and where the two differently formed parts join, there exists on each lid a slight conical elevation, the apex of which is pierced by the aperture of the corresponding lachrymal duct.'—QUAIN, vol. III. p. I.

The lachrymal apparatus is constituted by the following assemblage of parts—viz., the gland by which the tears are secreted at the outer side of the orbit; the two canals into which the fluid is received near the inner angles; and the sac with the duct continued from it, through which the tears pass to the interior of the nose. The description of these parts need not be quoted in detail here. Suffice it to say that the tears are secreted by the lachrymal gland, and poured out from the eyelids upon the eyeball; the washings afterwards running into the lachrymal sac, and thence by the nose.

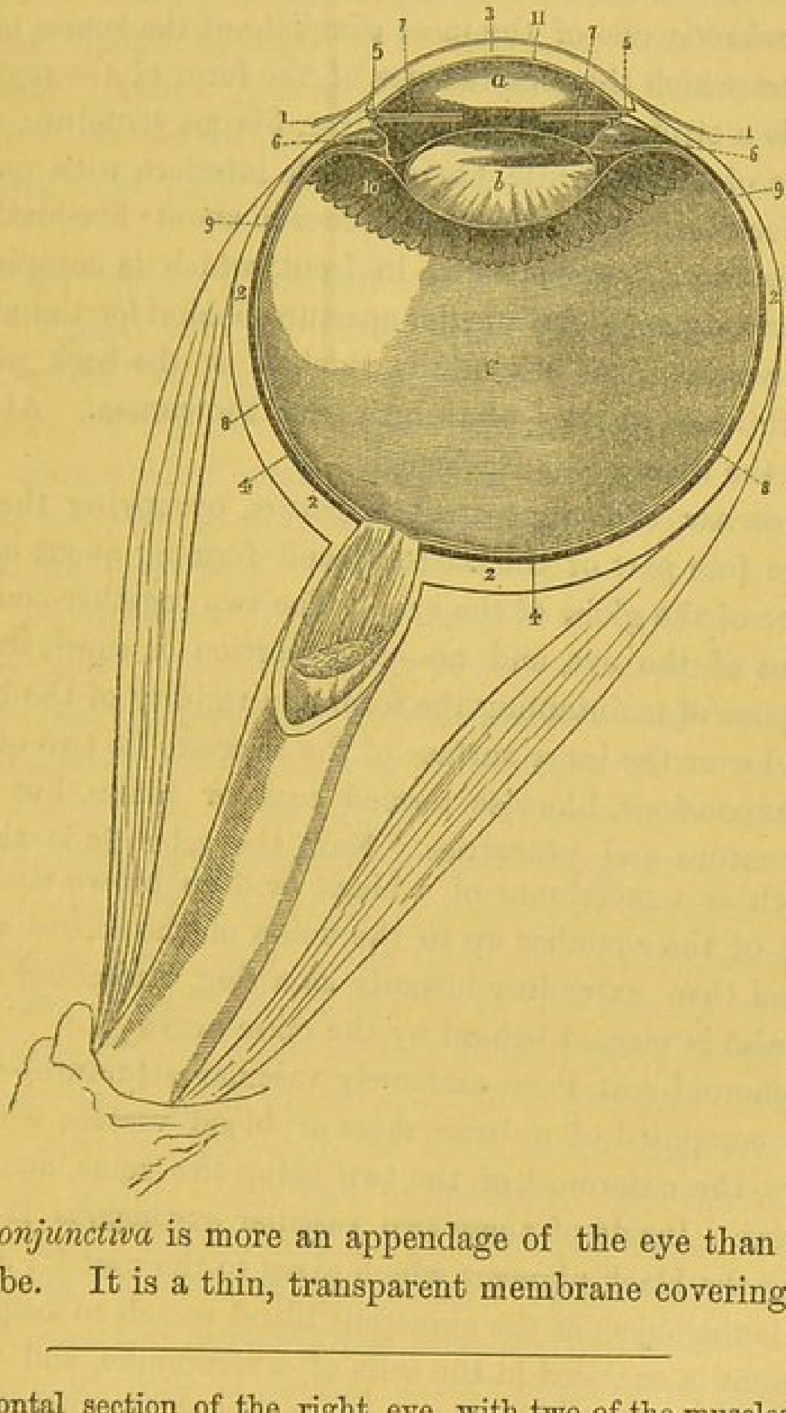
The parts now dwelt upon are not so much concerned in vision, as in expression and other functions auxiliary to vision. Though not directly bearing on the object of the present section, they will be of importance when we come to consider the emotions and their outward display. From them we now turn to the ball or globe of the eye.

'The globe, or ball of the eye, is placed in the fore part of the orbital cavity, fixed principally by its connection with the optic nerve behind, and the muscles with the eyelids in front, but capable of changing its position within certain limits. The recti and obliqui muscles closely surround the greater part of the eyeball; the lids, with the caruncle and its semilunar membrane, are in contact with it in front; and behind, it is supported by a quantity of loose fat. The form of the eyeball is irregularly spheroidal; and, when viewed in profile, is found to be composed of segments of two spheres, of which the anterior is the smaller and more prominent; hence the diameter taken from before backwards exceeds the transverse diameter by about a line. The segment of the larger sphere corresponds to the sclerotic coat, and the portion of the smaller sphere to the cornea.'

'Except when certain muscles are in action, the axes of the eyes are nearly parallel; the optic nerves, on the contrary, diverge considerably from one another, and consequently each nerve enters the corresponding eye a little to the inner or nasal side of the axis of the globe.

'The eyeball is composed of several investing membranes, concentrically arranged, and of certain fluid and solid parts contained within them. The membranes are three in number, an external fibrous covering named sclerotic and cornea, a middle vascular and pigmentary, in part also muscular, membrane, the choroid and the iris, and an internal nervous stratum, the retina. The enclosed light-refracting parts, also three in number, are the aqueous humour, the vitreous body, and the lens with its capsule.'

Fig. 8.*



The *conjunctiva* is more an appendage of the eye than a portion of the globe. It is a thin, transparent membrane covering only the

* Horizontal section of the right eye, with two of the muscles,—the external and internal recti,—and the optic nerve. *a.* Aqueous humour. *b.* Crystalline lens. *c.* Vitreous humour. 1. Conjunctiva. 2. Sclerotica. 3. Cornea. 4. Choroid. 5. Canal of Fontana. 6. Ciliary processes. 7. Iris. 8. Retina. 9. Hyaloid membrane. 10. Zone of Zinn, or ciliary processes of the hyaloid. 11. Membrane of aqueous humour.—(Wharton Jones *on the Eye.*)

front or visible portion of the ball, and reflected on it from the interior of the eyelids, of which it is the lining mucous membrane. Over the clear and bulging portion of the eye it is perfectly transparent, and adheres closely to the surface ; on the parts surrounding the clear portion it is less transparent, and contains a few straggling blood-vessels, which are seen as red streaks on the white of the eye.

'The *sclerotic*, one of the most complete of the tunics of the eye, and that on which the maintenance of the form of the organ chiefly depends, is a strong, opaque, unyielding, fibrous structure, composed of bundles of strong white fibres, which interlace with one another in all directions. The membrane covers about five-sixths of the eyeball, leaving a large opening in front, which is occupied by the transparent cornea, and a smaller aperture behind for the entrance of the optic nerve. The sclerotic is thickest at the back part of the eye, and thinnest about $\frac{1}{4}$ of an inch from the cornea. At the junction with the cornea it is thickened.

'The *cornea* is a transparent structure, occupying the aperture left in the fore part of the sclerotic, and forming about one-fifth of the surface of the globe of the eye.' The two together complete the encasement of the eye, and no other portion is employed for the mere purpose of maintaining the form and rigidity of the ball.

Spread over the inner surface of the sclerotic lie two other membranous expansions, likewise termed coats or tunics, but of totally different nature and properties. Next the sclerotic is the *choroid* coat, which is a membrane of a black or deep brown colour, lining the whole of the chamber up to the union of the sclerotic with the cornea, and then extending inwards as a ring stretching across the eye. It also is pierced behind by the optic nerve.

The choroid coat is an extremely vascular structure—that is to say, it is composed of a dense mass of blood vessels, which lie in two layers, the outermost of the two being the veins, and the other the arteries. Inside of these two vascular expansions is the layer containing the black pigment which gives to the coat its colour, and which it is the object of the numerous blood vessels to keep supplied. The pigment is enclosed in the cells of a membrane, and these cells are packed very closely together, and are about the thousandth part of an inch in diameter. Each cell has a transparent point in its centre, surrounded by a dark margin.

The retina, or the nervous coat of the eye, is placed next the choroid, but does not reach so far forward. If a strong light is thrown upon it through the pupil of the eye, it appears of a reddish colour, which is owing to its blood vessels. When examined after death it is pinkish and transparent. In the centre of the retina, and in the line of most perfect vision, is observed an elliptical yellow, or golden yellow, spot, about $\frac{1}{17}$th of an inch long and $\frac{1}{70}$th wide, in the middle of which is a dark depression called by the discoverer, Sömmerring, the central hole. It is not a hole, but a thinner portion of the retina. About $\frac{1}{25}$th to $\frac{1}{20}$th of an inch from the inner or nasal side of the yellow spot is a flattened circular papilla, corresponding with the place where the optic nerve pierces the choroid coat.

The retina consists of several layers. Beginning at the inside, which is in contact with the vitreous humour, we find a transparent membrane called the *limiting membrane*, whose thickness does not exceed $\frac{1}{50,000}$ of a inch. Next are the *ramifications of the optic nerve*, the fibres being arranged in fine meshes, and wanting the double outline. These fibres are exceedingly minute ; the average diameter is not more than the $\frac{1}{30,000}$ or $\frac{1}{40,000}$ of an inch ; while some are less than the $\frac{1}{100,000}$ of an inch in thickness. Because the fibrous layer, is a layer of *nerve cells or vesicles* resembling the vesicles that make up the grey substance of the brain. These are most abundant in the hinder or central parts of the retina : they vary from the $\frac{1}{6000}$th to the $\frac{1}{1500}$ th of an inch in diameter. Then comes a still more complicated layer called the *granular and fibrous layer*, which constitutes the link of connection between the retina and the choroid coat. It is made up of two distinguishable layers of little grains or nuclei, and a number of very fine filaments, with a direction perpendicular to the retina ; at their outer connection these filaments are the $\frac{1}{60,000}$th to the $\frac{1}{40,000}$th in diameter ; at their inner connection with the fibres of the optic nerve, they are from the $\frac{1}{80,000}$ to the $\frac{1}{120,000}$ of an inch in diameter. The inner of the two layers, making up the granular and fibrous layer, immediately adjoins the choroid, and is called the columnar, or *bacillar* layer, being made up of closely-packed perpendicular rods transparent and colourless, about $\frac{1}{1000}$of an inch in length, and $\frac{1}{30,000}$th of an inch in thickness. Interspersed with these are larger rods called cones, $\frac{1}{2500}$ of an inch in diameter. Each pigment cell of the choroid receives as many as six or eight of the cones, with a larger number of the smaller rods grouped round them. They are connected with the other parts of the retina by the fine perpendicular filaments. The functions of this bacillar layer are involved in the same obscurity as the relations of the choroid coat to vision.*

It is interesting to notice how those several elements are disposed in the yellow spot and its vicinity, where vision is most perfect. From the margin of the spot towards the central hole, the rods of the columnar layer, the nuclei resting upon them, and the fibres of the optic nerve, gradually diminish, and at last fade away. On the central hole nothing is left but the larger rods, or cones, with the fine perpendicular fibres, and the vesicles, which are here closer than anywhere else, there being one for every cone, and the layer being 7 or 8 cells thick. Those elements that thus disappear in the central hole, are, however very abundant near the margin of the yellow spot. The smaller rods take the place of the cones, and the fibres of the optic nerve are very abundant and close. Thus, if we take the yellow spot together with its immediate surroundings, we find there the retina most highly developed; and it is on this part that we can discriminate visible objects with the greatest delicacy. The unequal distribution of the different elements between the outer and inner parts of the yellow spot is remarkable.

Before pointing out the different bodies that make up the bulk of the eye, and enable it to act as an optic lens, I must call attention to several other substances of a membranous or fibrous character lying under the cornea and near the junction with the sclerotic coat. The first of these is a narrow circular band, of a greyish-white colour, close behind the junction above-named. The foremost margin, the thicker of the two, gives attachment to the circular curtain called the *iris.* The thinner and posterior margin is blended with the choroid coat, which here prolongs itself inwards in a series of radiated folds called the *ciliary processes.* The band, or ligament, thus giving the two-fold attachment to the iris and the choroid, is called the *ciliary ligament.* The ciliary processes lie behind the iris, and make a black, wrinkled, narrow rim, concealed from external view.

'The *iris* may rightly be regarded as a process of the choroid;

* The above estimates of size are mostly taken from Kolliker, being transformed from millimetres by dividing by 24, (instead cf 25 and a fraction,) to keep to round numbers.

it is continuous with it, although of a modified structure. It forms a vertical curtain, stretched in the aqueous humour before the lens, and perforated for the transmission of light. It is attached all round at the junction of the sclerotic and the cornea, so near indeed to the latter that its anterior surface becomes continuous with the posterior elastic lamina.' 'The anterior surface of the iris has a brilliant lustre, and is marked by lines accurately described by Dr. Jacob, taking a more or less direct course towards the pupil. These lines are important as being indicative of a fibrous structure.' When the pupil is contracted, these converging fibres are stretched; when it is dilated, they are thrown more or less into zigzags. The pupil is nearly circular, and is situated rather to the inner side of the centre of the iris. By the movements of the iris it is dilated or contracted, so as to admit more or less light to the interior; and its diameter under these circumstances may vary from about $\frac{1}{20}$ to $\frac{1}{3}$ of an inch.'—TODD and BOWMAN, Vol. II. p. 25.

The iris is thus to be considered as a muscular structure, its fibres being of the unstriped variety, or of the kind that prevail among the involuntary muscles, as the muscular fibres of the intestine. It is abundantly supplied with nerves. While the radiating fibres above described serve to dilate the pupil, a second class of fibres, arranged in circles round the opening and best seen at the inner margin and behind, operate in contracting it. The action is purely reflex, and is regulated by the intensity of the light. In the dark, or in a very faint light, the dilating fibres are tense and contracted to the full, making the pupil very wide. The stimulus of light brings the circular or contracting fibres into play, by a reflex or unconscious action, and contracts the opening. The changes thus effected are useful in adapting the eye to different lights, admitting a larger quantity with a feeble light, and a smaller quantity with one that is too strong. When this reflex power of adaptation reaches its limit, and the brilliancy is still too great, we then put forth the voluntary efforts of closing the eye, or of turning the head away from the object.

Behind the ciliary ligament, and covering the outside of the ciliary processes is a greyish, semi-transparent structure, known as the *ciliary muscle*. 'It belongs to the unstriped variety of muscle, and its fibres appear to radiate backwards from the junction of the sclerotic and cornea, and to lose themselves on the outer surface of the ciliary body. The muscular nature of this structure is confirmed by its anatomy in birds, where it is largely developed, as noticed by Sir P. Crampton.'—TODD and BOWMAN, II. 27.

A peculiar interest has come to attach to this muscle, from its supposed action in the ill-understood operation of adapting the eye to objects at different distances.

Passing now from the coats of the eye to the substance, we find three *humours,* or transparent masses occupying it in the following order: in the front is the *aqueous humour;* next, the *crystalline lens;* and backmost the *vitreous* humour.

The *aqueous* or watery humour is a clear, watery liquid lying under the cornea in front, and bounded behind by the crystalline lens and the folds of the ciliary processes. This humour is very nearly pure water, containing in solution a small quantity of common salt and albumen; and is enclosed in a membrane which is in contact with the inner surface of the cornea in front and the ciliary processes and lens behind. The liquid is partly before and partly behind the iris.

The *vitreous* or glassy humour lies behind the crystalline lens, and occupies the entire posterior chamber of the eye, being about two-thirds of the whole. It consists of a clear, thin fluid enclosed in a membrane, which membrane not merely surrounds it, but radiates inwards into its substance like the partitions of an orange, so as to make up a half-solid gelatinous body—the vitreous body, or posterior lens of the eye. These partitions are very numerous, and point to the axis of the eye, but do not reach to it; and consequently there is a central cylinder passing from front to back, composed only of the fluid of the body. The form of the vitreous body is convex behind, while before there is a deep cup-shaped depression for receiving the crystalline lens. The membrane that surrounds it on all sides, as well as entering into the interior, has a twofold connexion in front; it doubles so as to receive the crystalline lens between its folds, and it unites with the ciliary processes, which surround the lens without reaching its border. Thus the partition, between the aqueous humour in front and the vitreous humour behind, is made up of three successive portions enclosing one another;

the wrinkled black ring of the ciliary processes outermost; within this, a ring of the doubled membrane of the vitreous humour; and inmost of all, the crystalline lens, enclosed between the two folds of the membrane.

The *crystalline lens* is a transparent solid lens, double convex in its form, but more rounded behind than before. It is suspended between the aqueous and vitreous humours in the manner already described. Its convexity in front approaches very near the curtain of the iris stretched in front of it. The lens is enclosed in a capsule, and of this the front portion is thick, firm, and horny, while the portion on the back is thin and membranous, adhering firmly to the membrane of the vitreous humour. The substance of the lens varies in its character; the outside portion is soft and gelatinous; beneath this is a firmer layer; and in the centre is the hardest part, called the nucleus. It is supplied with blood vessels in the edges, but none appear to penetrate within except in a very early stage of life. It undergoes altogether a great change during the development of the individual. In the fœtus it is nearly spherical, and it is not perfectly transparent; in mature life it is of the form and character described above; while in old age it becomes flattened on both surfaces, loses its transparency, and increases in toughness and density.

Of the six *muscles* of the eye, four are called *recti* or straight, and two *oblique*. The four recti muscles arise from the bony socket in which the eye is placed, around the opening where the optic nerve enters from the brain, and are all inserted in the anterior external surface of the eyeball, their attachments being respectively on the upper, under, outer, and inner edges of the sclerotic. The superior oblique or trochlear muscle arises close by the origin of the superior straight muscle, and, passes forward to a loop of cartilage; its tendon passes through the loop, and is reflected back, and inserted on the upper posterior surface of the eyeball. The inferior oblique muscle arises from the internal inferior angle of the fore part of the orbit, and is inserted into the internal inferior surface of the eyeball, behind the middle of the ball.

The motions of the eyeball that would be caused by the contractions of any of these muscles are not difficult to trace. The inferior muscle, by its contraction, will make the ball revolve so as to look downwards; the superior straight muscle will make it look upwards. The internal and external recti will give it their respective directions, the one inward, the other outward. The action of the trochlear muscle is peculiar. Inasmuch as it is reflected backwards to be inserted in the globe of the eye, it will turn the eyeball downwards and outwards—that is, the eye would, by its action, look obliquely downwards and outwards. This muscle tends also to draw the ball of the eye a little forward, or to make it protrude. The inferior oblique muscle having its origin in the fore part of the orbit, and its insertion in the inner side of the eyeball, will, by its contraction, also draw the eye forward, and turn it upwards and inwards.

The external rectus is balanced by the internal rectus. The superior rectus is supported by the inferior oblique, in giving the eye its upward movement. The inferior rectus is supported by the superior oblique, in imparting the downward movement of the eye. There is thus a greater expenditure of muscular tension in moving the eye up and down than in the lateral movements. It is said that the effect of this is to give a greater impressiveness to the vertical dimension; the upright line of an equal cross seems the longer.

All the movements of the eye could be performed by three recti muscles and one oblique; the two others are, strictly speaking, supernumerary, but still operate. This makes it uncertain which muscles actually perform any one movement. The presumption is that we employ such muscles as in each case perform the movement with the least expenditure of force. Very few movements could arise from a single muscle. The movements possible by two muscles are not very numerous. Meissner gives twelve directions from the primary position of the eye, which is assumed as directed in a line 45° below the horizontal line. The eye, in passing from one part of the field to another, might be supposed to take the straight route. Wundt is of opinion that the straight route is preferred only in the horizontal and the vertical sweep. In other directions, the sweep is in a curve, which is greatest when the two points in the field of vision make an angle of 45° with the horizon.

3. Such being the mechanism of the eye, I must now touch briefly upon its mode of acting as the organ of sight. The optical part of the process is well enough understood. When the eye is directed to any object, an image of that object is depicted on the back of the eye, by means of the rays of light entering the pupil, and duly refracted by the different humours. The image, which is inverted, produces an impression somehow upon the retina, with the assistance of the choroid coat, and this impression passes inwards to the nervous centres, whence the optic nerve takes its rise. In order to perfect vision the following conditions are necessary:

(1.) A sufficiency of light or illumination in the object viewed. This is an obvious necessity. We judge of the quantity of light present by the power we have of seeing objects distinctly. Some animals can see with much less light than others, and to such the noonday sun must be painful.

(2.) The formation of the image exactly on the retina, and not before or behind. The focus of the image must coincide with the retina. If this is not the case the image is indistinct; the rays of light either do not converge, or have begun to disperse at the back of the eye. The perfect convergence of the image by the lenses constituting the ball of the eye, depends on the distance of the object, and also in some degree on the self-adjustment of the eye. 'As this power of adaptation of the eye itself for vision, at different distances, has its limits, there is in every individual a distance at which he sees most distinctly, and at which the focus of the image, formed by the refracting media of the eye, corresponds most accurately with the situation of the retina. This distance may be stated at from five to ten inches, in the majority of individuals. Objects which are too near the eye throw very indistinct images upon the retina; a slender body, such as a pin, held close to the eye, cannot be seen at all, or produces only an undefined impression on the retina. Few persons, on the other hand, are able to read print at a much greater distance than twenty inches.'

(3.) The third condition of perfect vision is the minute size of the sub-divisions of the retina capable of independent sensation. We are sensitive to very minute lines and points; and there is a limit of minuteness, where a number of distinct lines would seem as one. This is the limit of the optical subdivision of the retina, analogous to the intervals of double sensation in touch.

It appears that minuteness of discrimination is aided by the following circumstances. 1. An intense light will enable a smaller object to be seen. 2. A white picture can be seen smaller than a blue. 3 A line can be seen better than a point of the same diameter. The smallest angle for a round body is 20″; a thread-like object is discernible under an angle of 3″; a glancing wire can impress the eye at an angle of $\frac{1}{5}$″. According to Weber and Volkmann, two bright lines must be separated at least from $\frac{1}{6000}$ to $\frac{1}{12000}$ of an inch on the yellow spot to give a double sensation; which is an estimate quite compatible with the observed minuteness of the fibres and vesicles of the retina, supposing each of these capable of conveying an independent impression to the brain.

The power of discrimination diminishes rapidly as the impression recedes from the yellow spot. At a point 60° from the centre of the spot, an object must be 150 times larger, in order to be distinguished. Thus, although the eye can take in a wide field at once, the power of minute observation is confined to a very small part in the centre of the retina.*

* Another condition of perfect vision has been suggested by the following experiments:—If a small piece of red paper is held before the eye, and then moved to one side, without the eye following it, so that the impression is made just in the yellow spot, and then on the lateral parts of the retina, the colour is variously seen. To the yellow spot, the paper is red; as it moves sideways, it becomes darker; gradually, it assumes a blueish tint, and, at last, it appears perfectly black. Similar variations occur with any other colour, simple or mixed, and also with white, which unites all the colours. The last in the series is in all cases black. Whence it appears that different parts of the retina are differently sensitive to impressions of colour. The variation occurs in the same order in every direction, but with unequal rapidity. The series is passed through quicker, when the object is moved outwards, than when it is moved inwards; and also quicker for the upward than for the downward movement. It does not follow that in looking at a wide expanse

The great superiority of the eye, as a medium for perceiving the outer world, lies in this power of independent sensibility to minute points. I have already adverted to the distinction between the lower and higher senses in this particular. The nerve of vision must needs consist of a number of independent fibres maintaining their distinctness all the way to the brain, and capable of causing distinct waves of diffusion throughout the entire cerebral mass; every one of these many thousand impressions making a separate mental experience, and originating a distinct volition. We shall probably meet with no fact attesting more conspicuously the complexity, and yet the separateness of action, of the cerebral system. We can easily satisfy ourselves of the reason why the cerebral hemispheres should be necessary to vision, considering what is thus implied in every instance of seeing whatsoever.

4. *On the Adaptation of the Eye to Vision at different Distances.*—If I see an object distinctly six inches distant

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of one colour, we see the gradations of tint in concentric rings. This is a case where the mind overbears the sense. We have contracted our notion of each surface from the way that its parts affect us when brought successively before the yellow spot—the place of minute examination—and what we seem to see is the habitual effect, rather than the effect at the instant. I shall afterwards allude to an important application of this fact, suggested to explain our power of localising the different impressions made on the retina. I may advert here also to the phenomena of colour-blindness, and to the suppositions that have been made to account for it. We have already mentioned a speculation, to the effect that the different parts of the ear may respond to different tones or notes. A similar assumption has been extended to the eye. It is considered not unlikely that there are different nerve fibres and endings for the different primary colours, which endings are unequally mixed over the surface of the retina. It may be supposed that at one place violet rods predominate, at another green; and that in the yellow spot, the red endings are most abundant. Colour blindness would then consist in the deficiency or absence of one set of endings. The most frequent form of this defect is the absence of the primary sensation of redness; all coloured bodies are then seen as composed of green and violet. The spectrum to such persons is comprehended of a yellowish and a blueish tinge. What they call white, the ordinary eye sees to be coloured. Colour-blindness has been known to exist with reference to green, but as yet, not to violet.

from the eye, all objects at a greater distance are indistinct. The image of the near object falls correctly on the retina, the images of remote objects are formed in front of the retina. By a voluntary effort, I can adapt the eye to see a far off object with tolerable clearness, but it then happens that any near body becomes confused. The question arises, what is the change produced upon the eyeball, in the course of this adaptation from near to far, and from far to near, and what apparatus effects the change.

In seeing close at hand, the crystalline lense becomes thicker and more convex in front; in seeing at a distance the surface is flattened. The change of curvature is considerable. The centre-point bulges out $\frac{1}{48}$th of an inch for near vision. A very slight increase takes place in the curvature of the hinder surface.

The changes of curvature depend on the action of the ciliary muscle. This muscle contracts for near vision; the effect of the contraction is to draw the choroid membrane forwards, and by that means to compress the vitreous humour, which exerts a pressure on the lens, pushing it forwards. At the same time, the muscular fibres of the iris come into play, contracting the pupil and also the outer circumference. This brings a pressure to bear upon the lens from before, but not an equal pressure; it is least at the centre and greatest towards the edges. Between these two pressures, from behind and before, the lens is bulged out in the middle, and its curvature increased. Thus for near vision, there is a very considerable muscular action; when looking at anything very close, we are conscious of a strain in the interior of the ball. For distant vision, this action is relaxed, and the natural elasticity of the parts restores the flattening of the lens. Hence the natural repose of the eye makes the adjustment for a distant prospect.*

* The limits of single vision are illustrated by the following experiment. If a thread is moved against a white wall, and we observe it with one eye through a tube, we can feel a difference when it is moved nearer, but not when it is moved farther away. This is consistent with the circumstance, that in chang-

The eyeball is subject to alteration chiefly for near distances. Between the smallest visible distance, say four inches, and three feet, nearly the whole range of the adjustment is gone through. When we compare distant objects of varying remoteness, as, for example, thirty feet with one hundred, or a thousand, very little change is effected on the form of the eyeball, the adjustment then depending on the greater or less convergence of the two eyes. This leads us to the subject of double vision.

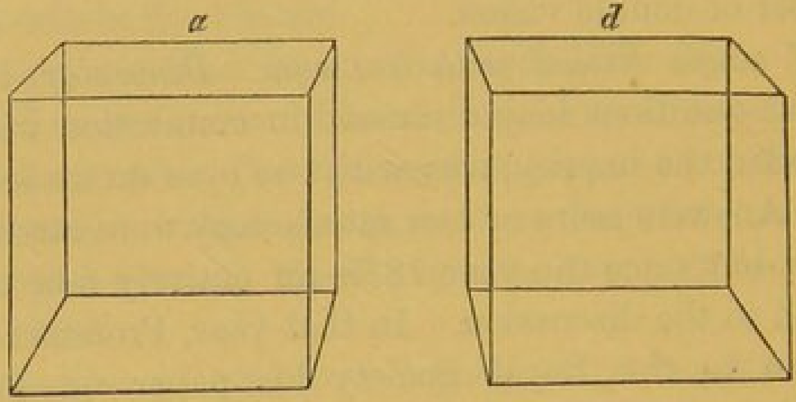
5. *Of single Vision with two eyes. Binocular Vision.*—Among the questions long discussed in connection with sight, was included the inquiry, why with two eyes do we see objects single? Answers more or less satisfactory were attempted to be given; but since the year 1838, an entirely new turn has been given to the discussion. In that year, Professor Wheatstone gave to the Royal Society his paper on Binocular Vision, wherein he described his 'stereoscope,' or instrument for imitating and illustrating the action of the two eyes in producing single vision. The following quotation is from the opening paragraph:—

'When an object is viewed at so great a distance that the optic axes of both eyes are sensibly parallel when directed towards it, the perspective projections of each, seen by each eye separately, are similar, and the appearance to the two eyes is precisely the same as when the object is seen by one eye only. There is in such case no difference between the visual appearance of an object in relief, and its perspective projection on a plane surface; and hence pictorial representations of distant objects, when those circumstances which would prevent or disturb the illusion are carefully excluded, may be rendered such perfect resemblances of the objects they are intended to represent, as to be mistaken for them; the Diorama is an instance of this. But this similarity no longer exists when the object is

ing to near vision, we cause a muscle to contract, while in changing to a more distant view, the natural elasticity of the parts releases an existing contraction. So, under the same circumstances, we may estimate the interval moved over by the thread, when it is brought nearer; but we can form no estimate of the absolute distance.—(Wundt.)

placed so near the eyes that to view it the optic axes* must converge, and these perspectives are more dissimilar as the convergence of the optic axes becomes greater. This fact may be easily verified by placing any figure of three dimensions—an outline cube, for instance—at a moderate distance before the eyes, and while the head is kept perfectly steady, viewing it with each eye successively while the other is closed. The figure represents the two perspective projec-

FIG. 9.



tions of a cube; *a* is seen by the right eye, and *d* is the view presented to the left eye, the figure being supposed to be placed about seven inches immediately before the spectator.'

'It will now be obvious why it is impossible for the artist to give a faithful representation of any near solid object, that is to produce a painting which shall not be distinguished in the mind from the object itself. When the painting and the object are seen with both eyes, in the case of the painting two *similar* pictures are projected on the retinæ, in the case of the solid object the pictures are *dissimilar;* there is therefore an essential difference between the impressions on the organs of sensation in the two cases, and consequently between the perceptions formed in the mind; the painting, therefore cannot be confounded with the solid object.'

It is this dissimilarity of the pictures that is the chief optical sign of solidity or of three dimensions. The greater the dissimilarity, the more decidedly is a third dimension suggested. Perfect similarity occurs in looking at things very

* The optic axis of the eye is the line of visible direction for distinct vision, or a line proceeding from the central point of the retina, and passing through the centres of the lenses of the eye.

remote, or in examining a surface at right angles to the line of vision, all the parts being equally distant. Thus, when we gaze at a painting close at hand, we are not deluded into the belief of its being a reality, from the absence of the criterion of dissimilarity. Anything near must have its parts at an equal distance from the eye, in order to present identical pictures, and we draw the inference accordingly. The stereoscope gives the illusion of solid effect by presenting to the two eyes dissimilar pictures, imitating the natural presentation in the case of an object or a scene unequally removed from the eye.

A great difficulty is experienced in explaining double vision, through mistaking the exact nature of the effect produced upon the mind by the impression made on the eye on one single occasion. We are apt to suppose that the entire conscious state at any one moment—the full imagery pictured to our view—is determined by the rays affecting the retina at that moment. The truth is, that what rises to the mind on the sight of an outward thing, is an aggregate of past impressions, which the impression of the moment suggests, but does not constitute. The education of the sense of sight makes us aware, that an identical impression upon both eyes concurs either with great distance, or with mere surface, that is, with two dimensions only, there being no inequality of distance from the eye. On the other hand, unlikeness of picture corresponds with the introduction of the element of unequal distance, and the more this inequality exists, the greater is the dissimilarity; and, accordingly, the mind, instead of being perplexed with double images, at once adopts the notion of a single complex object with varying remoteness, the variation being estimated among other signs by this very unlikeness of the pictures. It is immaterial whether the retinal presentations be two, as in binocular vision, or thousands, as in the vision of insects; these presentations are but the hint to a mental construction, representing the unity of the external scene, in its length, breadth, and depth.

6. Before quitting the consideration of the Eye, I should

mention that *the seeing of objects erect by means of an inverted image on the retina*, has been conceived as a phenomenon demanding explanation. But to make this a question at all, is to misapprehend entirely the process of visual perception. An object seems to us to be up or down, according as we raise or lower the pupil of the eye in order to see it; the very notion of up and down is derived from our feelings of movement, and not at all from the optical image formed on the back of the eye. Wherever this image was formed, and however it lay, we should consider that to be the top of the object which we had to raise our eyes or our body to reach.

7. And now as to the Sensations, or the proper mental elements of Sight. These are partly optical, resulting from the effect of light on the retina; and partly muscular, arising through the action of the six muscles. Nearly every sensation of sight combines both elements.

8. I shall commence with the sensation of mere *light*, and shall take the diffused solar radiance as the leading example. This is one of the most powerful of the simple influences that affect the human sense. Light is eminently a source of pleasure, which rises in degree, within certain limits, in proportion to the abundance of the luminous emanation. The degree is massive or acute, according as the effect proceeds from a diffused surface like the sky, or from luminous points, as in artificial illumination. In either case it is possible to obtain a considerable amount of pleasure from this source. As a cheering influence, light ranks with warmth, alimentation, and pleasant repose. On the principle of Relativity, the full effect is experienced only after confinement in the dark.

The speciality of the pleasures of light is their endurableness. The influence, although powerful, is yet gentle; it does not exhaust the nerves so rapidly as sweet tastes, pungent odours, or loud sounds. This is the great distinction of the sense of sight. Hearing also ranks high in the same property, but we must still assign to it the second place. One of the things understood by the term 'refinement,' as applied to pleasure, is this aptitude for being endured a great length of time without palling and satiety. The pleasures of sight are of a more lasting kind than those of the inferior senses. From this, and from some other circumstances that I do not here advert to, they enter into the feelings of the Beautiful. Light and shade, and the harmonious arrangement of colours, may suffice to constitute a work of fine art. The serene and soothing influence of sunshine furnishes a bond of connection between effects of light and the tender feeling. The explanation I believe to be, that pleasure, when voluminous and not acute, generally subdues the active excitement and the energetic disposition of the system, and so brings the mind into the state most congenial to the pleasures of tender emotion.

As regards Volition, the pleasures of light do not deviate from the general rule; that is to say, they are motives to the will, in proportion to their degree. But as regards Intellect, the sensations of vision have a marked superiority among the senses. They admit of being discriminated, and identified to an extraordinary extent, as will presently be seen; and they have a corresponding superiority as respects their being retained or remembered. These intellectual properties no doubt spring from the same cause as the endurability of the feeling as pleasure.

The perfect enjoyment of light demands alternation, and a certain measure in the amount. In sunny climates the exposure to it for the entire day is excessive and exhausting. It has to be balanced by artificial darkness and shade. Places where the full quantity is not afforded that human beings can derive enjoyment from, are styled gloomy and dull.

9. *Colour* introduces a mode of action distinct from the effect of white light. By a measured alternation of the different colours we gain a new pleasure, which has all the distinguishing peculiarities of the pleasure of light and shade. The decomposition of the solar ray into certain primary colours in fixed proportions, is an exact key to the harmony of colouring, or to the alternation most agreeable to the mind.

We commonly speak of the different colours as having characteristic effects; blue and green are considered as mild or soft; red is fiery, pungent, or exciting. The eye is fatigued with the glare of sunshine, and is said to find repose in the verdure of the fields. But these allegations cannot be maintained in an absolute sense. Colour, like all other things, operates in accordance with the principle of relativity. The effect of any single colour is due to the transition from others felt previously. If red were the one universal tint, we should never have recognised colour at all; we should have spoken only of light and dark. The effects attributed to redness are due to its contrast with the prevailing tints about us. Next to white light and shades of dull grey, we are familiarised to blue and green. The balance is usually in favour of the blue end of the spectrum, and hence the occurrence of red is a lively stimulation. If the proportions were reversed in nature; if red and yellow took the place of blue and green, these last would be the exciting colours: they would have the freshness of rarity and novelty. The pleasure of newly-discovered shades of colour, as the mauve and magenta dyes, has no foundation but novelty and contrast. The variegated aspects of the fields and gardens in the bloom of vegetation, have more beauty than the unbalanced verdure of the leaf. The diffusion of red and yellow supplies the wanting ingredients of the picture. The colours of sunrise and sunset are the scenic splendours of the sky.

10. Artificial lights owe their effect principally to their intensity. They usually fail somewhat in the proportions of white light, and, therefore, have an influence of colour in addition. The flame of a fire is an agreeable stimulation; the intensity does not amount to a painful excess. A light arrests and detains the eye; the fresh sensibility of childhood is delighted with the effect, and soon learns the voluntary movements for securing it when it is to be had.

11. There remains to be noticed the sensation of *lustre*. The lustrous is opposed to the dull. We commonly find this effect in bodies where a colour is seen through a transparent covering. An example is furnished by the pebbles at the

bottom of a clear pellucid stream. The pleasure of lustre is much greater than that of colour alone. The objects most prized for their optical beauty are the most intensely lustrous. The retinal sensibility is excited to the highest pitch by this effect.

An observation made by Dove assists us in understanding the circumstance that gives rise to lustre. He noticed that two drawings for the stereoscope, coloured differently, produced in their combination a lustrous effect, the separate colours being of a dull hue. We know that, in the case of bodies having the property in question, two sets of rays pass to the eye simultaneously—the rays from the transparent covering and those from the colour beneath. It would appear then that this union of rays is the condition of the agreeable stimulation. When the combination is made from two separate colours in the stereoscope, the colours are mixed into the proper compound colour, and are also lustrous. Two colours of different degrees of brightness will give the effect. The most lustrous bodies are naturally those where the transparency of the upper film is greatest, so as not to obscure the underlying colour.

In the case of transparent bodies such as crystal and diamonds, where no colour shines through, there is still the occasion for a coalition of rays. The surfaces of transparent bodies emit a two-fold ray, namely the ray of mirrored reflexion (as from mirrors, and from windows at sunset), and the ray of surface visibility. To this double emanation from the surface is to be added the reflexions from the interior surface, which may also be of the same two-fold character. A crystal with cut faces thus gives a plurality of white emanations occurring on the retina together, and consequently possesses in a high degree the supposed requisite of lustre or brilliancy. Indeed, the single power of mirror reflection in such surfaces gives them a brilliancy to the eye, especially in the presence of strong lights. This is still farther enhanced by the effect called total reflexion, an effect arising in the interior surfaces of strongly refracting crystals. The diamond is the highest example of this, and of every other property conducing to brilliancy.

The highest beauty of visible objects is obtained by lustre. The precious gems are recommended by it. The finer woods yield it by polish and varnish. The painter's colours are naturally dead, and he superadds the transparent film. This property redeems the privation of colour, as in the lustrous black. The green leaf is often adorned by it, through the addition of moisture. Possibly much of the refreshing influence of greeness in vegetation is due to lustrous greeness. Animal tissues present the effect in a high degree. Ivory, mother of pearl, bone, silk, and wool are of the class of brilliant or glittering substances. The human skin is a combination of richness of colouring with lustre. The hair is beautiful in a great measure from its brilliancy. The finest example is the eye. The deep black of the choroid, and the colours of the iris, are liquified by the transparency of the humours.

12. We have next to deal with the *complex sensations* of sight, those resulting from the combination of optical effect with the feelings of movement arising out of the muscles of the eyeball. As in the case of Touch, this combination is necessary as a basis of those perceptions of the external world that are associated with sight—Externality, Motion, Form, Distance, Size, Solidity, and relative Position. It is maintained that mere light and colour will not suffice to found these perceptions upon, and it is my object here, as in the discussions on Muscularity and Touch, to refer them to the moving aparatus of the eye and of the body generally.

13. I shall commence with *motion*. One of the earliest acquired of our voluntary actions is the power of following a moving object by the sight. Supposing the eye arrested by a strong light, as a candle-flame, the shifting of the candle would draw the eyes after it, partly through their own movements and partly by the rotation of the head. The consequence is a complex sensation of light and movement, just as the sensation of a weight depressing the hand is a sensation of touch and movement. If the light moves to the right, the

right muscles are engaged in following in it; if to the left, the left muscles, and so on; and thus we have several distinct combinations of light and muscular impression, marking distinctness of direction, and never confounded with one another.

Motion, instead of continuing in one direction, may change its direction, and take a course crooked or curved. This brings into play new muscles and combinations, and leaves behind a different trace of muscular action. The right muscles of the eye may have to act along with the superior muscles, and at a shifting rate. This will give an oblique and slanting direction, which we shall ever afterwards identify when the same muscles are similarly brought into operation. We have thus a perfect discrimination of varying directions, through the distinct muscles that they excite.

We can with the eye, as with other active organs, discriminate the greater or less *continuance* of a movement, and thereby estimate Duration in the first instance, and, in the next place, obtain another instrument applicable eventually to estimating Extended Magnitude.

Our muscular sensibility also discriminates rate or *velocity* of movement. A quick movement excites a different feeling from one that is slow; and we thence acquire graduated sensations, corresponding to degrees of speed, up to a certain limit of nicety. This estimate of the rate of contraction also indirectly serves as a means of judging of Extension, after the notion of visible Space, as opposed to Succession in Time, has been arrived at. The muscular sensibility of the dead strain, or of Resistance, can scarcely occur in the eye, there being nothing to resist its movements but its own inertia. What is called straining the eye, (which happens in close and minute vision), is not the same thing as straining the arms in the support of a heavy weight. Hence of the three primary sensibilities of muscle—resistance, continuance, and speed—two only belong to the ocular muscles. Accordingly the eye, with all its superiority in giving the mind the pictorial array of the extended world, cannot be said to include the fundamental consciousness of the object universe, the sense of Resistance. There is a certain kindred sensibility in the common fact of muscular tension; but it is by association, and not by intrinsic susceptibility, that the power of vision impresses us so strongly with the feeling of the Object world.

While the retina of the eye thus receives one and the same optical impression (in the supposed case of the candle-flame), this may, by movement, be imbedded in a great many different muscular impressions, and may constitute a great variety of pictorial effect. By changing the muscles and by varying their rate of action, we may so change the resulting impressions, that any one motion shall be recognised by us as distinct from every other, while each may be identified on a recurrence.

Many of the pleasures of muscular movement, described in the previous chapter, may be experienced in the *spectacle* of moving objects. The massive, languid feeling of slow movement, the excitement of a rapid pace, the still higher pleasure of a waxing or waning speed, can all be realized through the muscles of the eye and the head. The slow procession, the gallop of a race-horse, the flight of a cannon-ball, exhibit different varieties of the excitement of motion. In the motion of a projectile, where a rapid horizontal sweep is accompanied with a gentle rise and fall, we have one set of muscles in quick tension and another set in slow varying tension, thereby contributing the still more agreeable effect of increasing and dying motion. While the projectile flies across the field of view, the horizontal motion is uniform, but the pace upwards diminishes, and at last dies away at the highest point; the body then recommences a downward course, slow at first, but accelerating until it reach the ground. Hence arises the beauty of curves.

The pleasures of moving objects and stirring spectacle count for much in the excitement of human life. They are really pleasures of action; but inasmuch as only a very limited portion of muscle is excited by them, they do not constitute bodily exercise, and are therefore, to all practical intents, passive pleasures, like music or sunshine. Thus dramatic display, the ballet, the circus, the horse race, the spectatorship of games and sports, although engaging the activity of the eye, do not belong properly to active enjoyments. They may, however, be the means of stimulating the general activity of the frame.

14. Among the permanent imagery of the intellect, recalled, combined, and dwelt upon in many ways, we are to include visible movements. The flight of a bird is a characteristic that distinguishes one species from another, and the impression left by it is part of our knowledge or recollection of each individual kind. The gallop of a horse is a series of moving pictures that leave a trace behind them, and are revived as such. The motions that constitute the carriage and expression of an animal or a man, demand particular movements of the eye, in order to take them in and store them up among our permanent notions. All the gestures, modes of action, and changes of feature that emotion inspires are visible to the eye as an assemblage of movements, and we recognise such movements as marking agreement or difference among individuals and in different passions. Many of the aspects of the external world impress themselves upon the moving apparatus of the eye. The surface of the sea, the drifting of clouds, the fall of rain, the waving of trees in the wind, the rushing of water, the darting of meteors, the rising and setting of the sun, are all mixed impressions of spectacle and movement. In like manner, in the various processes of the arts, there are characteristic movements to constitute our notions and our means of discrimination of those processes. The evolutions of an army have to be remembered as movements, and therefore need to be embodied among the muscular recollections of the system.

15. Before entering on the consideration of Extension and Form, it is proper to allude to the discriminative muscular sensibility corresponding to changes in the *distance* of objects from the eye. We have already seen that there is a double adaptation of the eye to distance, namely, a change in the

ball, for near distances, and an alteration in the direction of the two eyes, or in the parallelism of the axes, for distances both near and far. These adaptations are undoubtedly muscular; that is, they consist in the greater or less contraction of particular muscles. Now, the contraction of muscles in any part whatever yields a distinct feeling; we are conscious not only of the fact of tension, but of different ranges of tension. Hence every change in the interior of the ball by muscular influence, and in the convergence of the axes, causes a change of feeling; we have a discriminative consciousness of all the different stages of adaptation. The consciousness of distinct vision at six inches is never confounded with the consciousness of a foot, and this last is widely different from the feeling of a hundred feet.

Thus, therefore, the eye gives us a means of distinguishing objects, according as they are far or near, through the feelings consequent on the muscular adaptation for securing distinctness of vision. An object moving away from the eye in a straight line, would give us a changing sensation no less than an object moving across the field of view. An object moving obliquely, that is receding or approaching, while going across the view, would give a complex feeling, embodied in the movements of the eye and the head, and in the movements of adaptation.

The movements of adjustment may also give rise to pleasurable feeling. After viewing near objects for a length of time (which, however, is apt to involve a painful strain), there is an agreeable effect in the change from the near adjustment to a remote prospect. We may likewise derive the special enjoyment of gradually increasing or gradually diminishing movements.

16. We have taken the case of moving objects as the least complicated experience of vision. We must now enquire by what process we perceive visible form and extension, and acquire the notion of Simultaneous existence in *Space*. It has to be shown that the eye is active in the observation even of still life; the special mode of activity being such as to make

the mind feel the difference between Succession and Co-existence.

When we follow a moving object, as a rocket, or a bird, and when we carry the eye along the curve of the rainbow, there is a common fact of movement, with important differences in the mode. These differences are, to a great degree, parallel to those described under Touch, whereby the knowledge of objects as co-existing is attained. In the first place, in following the outline of the rainbow, we are not constrained to any one pace of movement, as with a bird or a projectile. This alone would give a lively sense of difference between the two appearances. In the next place, the optical impression, in the case of a still form, is not one unchanging sensation, but a series of sensations, which may be of the same nature as the rainbow, or may be all different as in sweeping across the clouds or the landscape. In the third place, we can by an inverted movement, encounter the same series of optical sensations, in the inverted order; whereas, in the other case, the object passes finally away from the sight. In the fourth place, we may repeat the movement, and in so doing obtain the same series of sensations, in the same order. Both in touch and in sight, this circumstance is probably what, more than anything else, gives us that vivid sense of the difference between objects moving and passing away—thereby typifying Succession—and objects that are simultaneous or co-exist, which is the meaning of Space. The more frequently we experience this fixed recurrence of optical sensations, in company with a definite movement, the broader is the line between that mode of existence and the objects that give us only one chance of observing them. The constant reception of a definite series of sensations by one definite movement, and the equally constant occurrence of the series inverted under an inverted movement, go far to make up our notion, meaning, and expectation, of objects extended in visible space.

But, in the fifth place, as regards Sight, the peculiar power of the eye to embrace at one glance a wide prospect, although minutely perceiving only a small portion, is available to confirm the same distinction. When the glance is carried along the field of view, the portions that cease to occupy the centre of the eye, still impress the retina, and have a place in the consciousness, though much less distinctly perceived. This constitutes an additional distinction between the transitory flight of a meteor and the picture of the starry sphere. Touch possesses this means of discrimination only in a very limited degree. The extended surface of the hand, the plurality of fingers, the united touch of the two hands, and such extent of the surface of the body as can make a simultaneous contact—correspond in some small degree to this great prerogative of sight, in giving a plurality of simultaneous impressions, so as to mark the difference between the co-existing in Space and the successive in Time. When a definite series of successive sensations are *simultaneously* felt, they suggest the fact of movement, which is involved in every perception of the extended.

Thus, then, the observation of still life is a combination of the movements of the eye, with the optical impressions corresponding to the different parts of the field of view. Exactly as in the case of moving things, by a horizonal sweep we take in a horizontal line ; by a circular sweep we derive the muscular impression of a circle ; by a sudden change of direction we are cognizant of an angle ; there being in all these instances the persistence in the retina of the whole figure, while the eye scans the successive parts.

The transition is easy from lines to surfaces. A more numerous and complex series of movements is requisite to give the impression of a visible area or superficies. But the same constant series of optical effects, imbedded in the same movements, inverted and repeated as oft as we please, enters into the cognition of space in two dimensions, as well as in the case of linear magnitude, or space viewed in one dimension.

By combining now the changes of adjustment, and the definite optical effects accompanying them, with the movements across the field of view, we attain to the visible experience of a third dimension, or Solidity. The recognition of difference of remoteness from the eye, in so far as can be done by vision alone, is the fusing of definite changes of adjustment with a definite series of optical impressions; the series being inverted by an inverted adjustment, and being repeated in the same order any number of times. Thus the vista of a street is a portion of our conception of the co-existing, or visible Space, and is made up of varying adjustment and optical sequences in a definite and unvarying combination. With the near adjustment, one class of objects are imaged distinctly to the mind; with an altered adjustment, these objects, although still in the view, fade into a characteristic indistinctness, and a new portion of the sphere attains the clearness of outline that the others formerly had. With another adjustment, the same optical change is repeated, and so on till the eyes have gone through the entire compass of accommodation to distance. It should not be forgotten, as a part of the optical differences of impression, that when the accommodation is proceeding from near to far, objects of the same nature, as trees, houses, men in a row, steadily diminish in their visible magnitude, or the extent of their image in the retina—a change that the mind cannot fail to be struck with, as a part of the optical series that keeps company with the progressive changes of adjustment.

By combining this impression of varying distance with the sweep of the eye over the field of view, we have the visible picture of all the three dimensions of space. We recognise objects in their solid form, and trace out the perspective of the scene around us. We are then prepared for acquiring permanent impressions corresponding to the visible expanse of the object world. Everything seen by the eye is a compound of colour, and of form in one, two, or three dimensions. By a series of appropriate movements we scan the outline of an object and sweep over its area, imbibing optical effects in company with muscular feelings. The union of those that are characteristic of each object is our permanent impression of that object, and is our means of recognising it in after times. With the explanations now given as to the difference between the co-existing and the successive, the language used to express the acquisition of visible movements, applies also to visible forms in still life.

The intellectual imagery derived through the eye from the forms of still life is co-extensive with the visible creation. For the purposes of discrimination and of identification of natural things, and also for the storing of the mind with knowledge and thought, the sensations of objects of sight are available beyond any other class. The eye is kept constantly at work upon the surrounding scene, following the outlines and windings of form, as these extend in every direction; and by the movements thus stimulated, each several object is distinguished from those that differ in shape, size, or distance, and identified with itself and those that coincide with it in these peculiarities. The train of movements for a square are recognised as distinct from the train that describes an oval: the outline of a pillar brings on a cycle of motions wholly different from those dictated by the figure of a tree. The property belonging to the mental system of causing movements to cohere that have been described in succession, fixes the series for each different view, and gives a permanent hold of all the distinct forms presented to the eye. This adhesive process belongs to the intellect, and will be fully treated of in the proper place. What is chiefly notable here is the fact, that the impressions of light made on the retina of the eye, and the accompanying muscular impressions rising out of its form-tracing mobility, are, both the one and the other, of a very enduring kind; they take on the coherence that gives them an existence after the fact, more easily than any other class of sensible impressions. Neither tastes, nor smell, nor touches, nor sounds, can compare with sights in the property of mental persistence and revivability. Probably no other muscles are equal in susceptibility to the muscles of the eye; hence their educational accomplishments, that is to say, the number of separate forms and combinations that they can retain a hold of, are pre-eminent among the acquirements of the muscular system.

CHAPTER III.

OF THE APPETITES.

1. IN taking up at this stage the consideration of the Appetites, I do not mean to assert that these entirely belong to our primitive impulses, or that in them the operation of intellect and experience is excluded. On the contrary, I am of opinion that Appetite, being a species or form of Volition, is like all our other effective forms of volition, a combination of instinct and education. But the process of acquisition is in this case simple and short; while, on the other hand, the stimulus to action, or the source of the craving, is usually one of the sensations or feelings discussed in the two previous chapters. Indeed, if we look at the craving alone, without reference to the action for appeasing it, that craving is merely what we have all along styled the volitional property of the sensation.

If a spur to action were to constitute Appetite, all our pains and pleasures would come under this designation. But the Appetites commonly recognised are a select class of feelings; and are circumscribed by the following property—namely, that they are *the cravings produced by the recurring wants and necessities of our bodily, or organic life.* The avoiding of a scald, a cut, or a fall, is an energetic impulse of volition, and yet not a case of Appetite; there being no periodic or recurring want of the system in these cases. *Sleep, Exercise, Repose, Thirst, Hunger, Sex,* are the appetites most universally present throughout the Animal tribes.

2. The fact of periodic recurrence is in no case more strikingly exemplified than in *Sleep.* After a certain period of waking activity, there supervenes a powerful sensation of repose. If we give way to it at once, the state of sleep creeps over us, and we pass through a few moments of agreeable

repose into unconsciousness. If we are prevented from yielding to the sleepy orgasm, its character as an appetite is brought out into strong relief. The voluminous uneasiness that possesses all the muscles and organs of sense, stimulates a strong resistance to the power that keeps us awake; the uneasiness and the resistance increasing with the continued refusal of the permission to sleep, until the condition becomes intolerable, or a reaction ensues, which drives off the drowsiness for some time longer.

The overpowering influence of drowsiness is best seen in infants, there being scarcely anything that will effectually appease the mental disturbance caused by it. The strong expressions that extreme pain sets loose—tears and rage—are never more closely at hand than in the sleepy condition.

3. The necessity of alternating *Exercise* with *Repose*, through the entire range of our active organs, brings on the like periodic cravings and deep-seated uneasiness. The fresh condition of the muscles is of itself a sufficient stimulus to action; without any conscious end, in other words, without our willing it, action commences when the body is refreshed and invigorated. If this spontaneous outburst is checked, an intense uneasiness is felt, being one of the conscious states incident to the muscular system. This state is of the nature of all the other appetites, and increases with privation, unless, by some organic change, the fit passes over for the time. The dog chained up to his couch, the exuberancy of childhood restrained from bursting out, the bird in its cage, the prisoner in his cell—experience all the pains and desire of the active organs for exercise. On the other hand, after exercise comes an equally powerful craving and impulse to rest, which, if resisted, produces the same intense uneasiness, until a febrile reaction ensues, and disorders the indications that the system gives respecting its wants.

Under this head of Exercise and Repose I might include the more active of our senses, that is, Touch, Hearing, and Sight. These senses all embody muscular activity along with the sensation peculiar to each; and both the muscular activity and the tactile, auditory and visual sensations, lead to weariness of the parts, with a craving for rest; while, after due repose, they resume the fresh condition, and crave for the renewal of their excitement. But the alternate exercise and rest of the senses is in a great measure involved in the rotation of sleeping and waking; seeing that the involuntary torpor of the nervous system, is almost the only means of giving repose to such constantly solicited senses as Sight, Touch, and Hearing.

A similar train of remarks might be extended to the activity of the thinking organs. But in these, the periodic cravings are less distinctly marked, and more frequently erroneous, than in the case of muscular exercise. There is often a reluctance to engage in thought, when the brain is perfectly vigorous and able to sustain it; and on the other hand, there is in nervous temperaments a tendency to excess of mental action, uncorrected by any regular promptings to take repose.

I may further remark, what is probably familiar to most persons, that a sense of fatigue may arise soon after commencing any laborious operation, which disappears after a time, and is not connected with real exhaustion.

4. *Thirst* and *Hunger* I have already touched upon 'What is called *thirst* is sometimes rather a call for the cooling influence of cold drinks, as for instance, in the dry, hot, state of the air-passages, mouth, and skin, produced in fevers by the increased temperature and diminished turgescence of the parts. Exhalation is in such cases often rather diminished, and the dryness of the surface arises from the circumstance that although blood still flows through the capillary vessels, the reciprocal action between the blood and the living tissues, which is denominated turgescence, or *turgor vitalis*, is depressed.'*

Hunger, unlike Thirst, is a state of the stomach, as yet not exactly understood; while the feeling of inanition, which also grows out of long fasting, must be considered as a general

* Müller, by Baly, p. 530.

feeling of the system. The urgency of hunger ought to be in accordance with the actual deficiency of nutritive material, but very frequently the case is otherwise. 'It is heightened by cold baths, by friction of the skin, by friction of the abdomen, and by the agitation to which the abdomen is subjected in horse exercise, as well as by muscular exertion.' It is diminished by all nauseating influences, which probably at the same time weaken the digestion. 'The local sensations of hunger,' says Müller, 'which are limited to the digestive organs, and appear to have their seat in the nervus vagus, are feelings of pressure, of motion, contraction, qualmishness, with borborygmi (gripings), and finally pain.'

In the case of hunger, as in most of the appetites, there is a double spur to the taking of food; first, the stimulus of uneasiness, and next the impulse arising out of the pleasure of eating. It is well understood that these two things are quite different, for on their difference hangs the whole art of refined cookery. Very plain food would satisfy the craving for nutrition, but there is a superadded pleasure that we have to cater for. The one is the appetite in its strictest signification, and as found in the lower animals; the other I might call a desire, because it supposes the remembrance and anticipation of a positive pleasure, like the desire for music, or for knowledge.

It is in the process of taking food and drink, that we best see exemplified the activity springing out of the sensations of hunger and thirst. The actual assuaging of the uneasiness produces an intense pleasurable sensation that sets on the most vigorous movements for being continued and increased; while the moving organs themselves, beginning to be invigorated, display a spontaneous and lively energy in the cause. To bring together, and make to unite, the sensation of the appeasing of hunger with the acts of sucking, swallowing, or prehension, is perhaps the earliest link of volition established in the animal system. This is the first case of action for an end, or under the prompting and guidance of a feeling, that the newly born infant is capable of. Eating is the most animated display of movement and action that a healthy carnivorous creature can present. There is something intensely kindling in the appetite of the carnivora for food, which rises to fury when the flesh is scented out and begins to be tasted.

Besides the natural craving for the elements of nutrition required by the tissues, we may acquire artificial cravings by the habitual use of certain forms of food, and certain accompaniments, as peppers, flavours, &c. Thus we have the alcoholic craving, the craving for animal food, for tea, coffee, snuff, tobacco, &c. The use of these articles having given a peculiar tone to the stomach or the nerves, a want is felt when they are withheld.

5. The Appetite that brings the Sexes together is founded on peculiar secretions which periodically accumulate within the system, producing a feeling of oppression until they are either discharged or absorbed, there being a certain intense pleasure in discharging them for the ends of reproduction. If we were to place these feelings among Sensations, they would either form a class apart, or they would fall under the first class above described, namely, the Sensations of Organic Life. If the subject were open to full discussion, like the other feelings of human nature, it might be best to treat them as the foundation of one of the Special Emotions expounded at large in a treatise on Emotion in general. We have in this case as in Hunger, both Appetite and Desire; but we have also, what does not occur to a like degree in the former mentioned craving, a many-sided susceptibility to inflammation,—through all the senses, through the trains of thought, and through emotions that are not sensations. The circumstances that concur in an individual of one sex to produce the excitement in the opposite sex, by sight, sound, or smell, as well as by touch, have not hitherto been fully investigated.

6. The accustomed *routine* of life leads to a craving almost of the nature of Appetite. As the time comes round for each stated occupation, there is a tendency or bent to proceed with that occupation, and an uneasiness at being restrained. Our appetites, properly so called, may have their times of recur-

rence determined by our customary periods of gratifying them.

7. All the appetites are liable to be diseased or perverted, so as to give false indications as to what the system needs. They are likewise liable to artificial and unseasonable inflammation, through the presence of the things that stimulate and gratify them. In the lower animals, it is assumed, I know not with what truth, that appetite rarely errs ; in humanity error is extremely common. We are apt to crave for warmth when coolness would be more wholesome ; we crave for food and drink, far beyond the limits of sufficiency ; we indulge in the excitement of action when we ought to cultivate rest, or luxuriate in repose to the point of debility. So false is the appetite for sleep, that it is still a dispute how much the system requires. Perhaps the complicacy and conflicting impulses of the human frame, are the cause of all this uncertainty and mistake, rendering it necessary for us to resort to experience and science, and a higher volition than appetite, for the guidance of our daily life.

CHAPTER IV.

OF THE INSTINCTS.

1. IN the present chapter, I mean to consider the various primitive arrangements for action that may be traced as belonging to the human system. It is a part of the plan of this work, to attempt to strip off the covering of acquired faculties, and ascertain what is the original mechanism that we start from in making our various acquisitions. This is to descend to the instinctive, intuitive, or primordial, in the human mind.

Instinct is defined by being opposed to acquisition, education, or experience. We might express it as the *untaught* ability to perform actions of all kinds, and more especially such as are necessary or useful to the animal. In it a living being possesses, at the moment of birth, powers of acting of the same nature as those subsequently conferred by experience and education. When a newly dropped calf stands up, walks, and sucks the udder of the cow, we call the actions instinctive.

2. In all the three regions of mind,—Feeling, Volition, and Intellect,—there is of necessity a certain primordial structure, the foundation of all that a human being ever becomes. There are also certain arrangements not included in the sphere of mind proper, that yet form links in our mental actions; as, for example, the reflex movements already noticed. In order to exhaust the various primitive arrangements, both unconscious or involuntary, and conscious or voluntary, I shall proceed in the following order :—

I. The *Reflex Actions.*—These are not proper mental elements, but their discussion is of value, both because they illustrate mind by contrast, and because certain useful functions are served by them, such as would otherwise have to be provided for by volition or true mental activity.

II. The primitive arrangements for *combined and harmonious actions.* These have already been glanced at, in the description of the functions of the cerebellum. The use of the locomotive members,—in walking, flying, swimming, &c.,—is the most prominent instance. These arrangements, if not mental, in the strict sense, are at least auxiliary to the voluntary operations.

III. The connexions existing at the outset between *Feeling* and its bodily manifestations.

IV. The instinctive germ of *Volition.* What we call the power of the will, has to be traced back, if possible, to some inborn or primitive stimulus, connecting together our feelings and our actions, and enabling the one to control the other. This is perhaps the most delicate inquiry that our science presents.

The primitive foundations of Intellect, I shall defer till the whole subject is entered on in the Second Part.

V. The description of the special mechanism of the *Voice,* will receive a place at the conclusion of this chapter, not having been included in the chapter on Movement.

OF THE REFLEX ACTIONS.

3. In discussing the functions of the Spinal cord and Medulla Oblongata, I enumerated the actions termed automatic or reflex, see p. 49. They are, 1st, those connected wit Digestion, namely, Deglutition, and the propulsion of the food through the alimentary canal. 2nd, Those connected with Respiration, including the movements of the lungs in Breathing, Coughing, Sneezing. Sucking in infants is also purely reflex (Brown-Séquard's Lectures, p. 229). 3rd, The winking of the Eyes. Of these some are free from the participation of consciousness, as Breathing, and the Alimentary Movements following deglutition. The winking of the eyes is also independent of consciousness, to this extent, that it operates whether we feel it or not; but the action ceases in

sleep. Coughing and sneezing are essentially conscious, but they are also involuntary; that is, the mechanical irritation works the riddance of itself, by a reflex act. If a voluntary effort were needed in the case of coughing, that effort would probably be made, in answer to the painful feeling produced by the substance in contact with the surface of the bronchia. In sneezing, the feeling is not always painful, but may be simply pungent, as in taking snuff, or in applying the nose to smelling salts. But although these actions are usually accompanied with feeling, they may be stimulated when we are in an unconscious state. The act of coughing will come over a person in sleep from the accumulation of phlegm. So, by applying snuff to the nose of a sleeper, the sneezing action will be brought on, and will precede and cause his awakening. These remarks on the partly unconscious and partly conscious character of the automatic actions, are necessary to clear up the distinction between the actions that are properly mental or voluntary, and those that are not.

4. There is a certain amount of reflex action generated in the operation of the various senses. A stimulus of any one of the organs of sense, besides rendering us conscious, and wakening up the movements constituting the expression of feeling, seems to excite a peculiar responsive action in the member where the organ is placed, or where the stimulus is applied; this is the principle of *sensori-motor*, or sensori-reflex actions. Thus, an object placed in the hand not only gives a feeling or sensation of touch, together with the attitudes and expressions proper to that feeling, but also directs a special response towards the muscles that move the fingers. There is a reflex tendency to close the hand upon anything placed on the palm, as may be seen by trying the experiment upon a child before its voluntary movements are developed, and still more strikingly if the child is asleep. If the finger is pricked or scalded, there is a keen emotion felt, and a lively excitement occurs all over the body in consequence, but the movement excited in the arm and hand affected is the most vehement of all. So by stimulating the sole of the foot, movements of the

leg are excited, over and above the general excitement due to every sensation according to its intensity. Some physiologists regard the contact of the foot with the ground, as a stimulus that aids in keeping up the act of walking. In like manner, by pinching the cheek or the face, the head is put in motion even in infants yet unable to localise their sensations. These reflected acts are to be included among our useful or practical instincts. In the matter of retracting a member from injury, the tendency is a protective one.

In the sense of taste, we see a special responsive stimulus of the muscles of the parts where the seat of sensation lies. A bitter taste produces wryness and contortion of the mouth: just as a bad smell operates most energetically upon the muscles of the nose. The responsive action of sight would naturally fall either upon the muscles of the eyeball itself, or upon those that surround the orbit, and move the eyebrows and eyelids. By an action purely and unconsciously reflex and involuntary, the pupil of the eye is contracted under a strong light; by an action partly voluntary, but possibly in some degree due to a special reflex connection between the optic centres and the muscles of the orbit, the eyelids and eyebrows are drawn down under the same influence. This last action I would compare to the retractation of a pinched limb, the wry mouth under a bad taste, and the contortions of the nose by a powerful smell. I do not profess to attach very great importance to this sensori-reflex action, the whole extent of the influence of it being but small in the human subject. At one time I was disposed to agree with Dr. Carpenter's view of Sensori-motor actions* as a class apart from

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* Dr. Carpenter, in endeavouring to constitute a class of sensori-motor actions (*Human Physiology*, § 748, 4th edit.), has laid hold of a number of movements and effects due, as I conceive, to the proper diffusive influence of feeling. 'The involuntary laughter produced by tickling' is a part of the emotional excitement of feeling, just as the contortions of the system under pain are a part of the pain. If it be true, as I believe, that every emotional state has a diffusive influence over the body, just in proportion to the intensity of the emotion or consciousness, an infinity of movement and display

others, and having a distinct and prominent efficiency, but although I freely admit the principle of a sensori-motor excitement directed especially to the organs where the seat of sensation is lodged, I think it comparatively (not entirely) insignificant both in nature and in amount.

OF THE PRIMITIVE COMBINED MOVEMENTS.

5. The explanation already gone into respecting the functions of the cerebellum, has led us to recognise certain cases of concurring or associated movements, wherein the associating link is found in the original conformation of the nerves and nerve-centres. The movements of the Two Eyes are an example; it is by no process of education that the eyes go always together. Again there are instances of regular sequences of movement, as in the successive strokes of the Heart's action, the alternating movements of Breathing, the

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must follow from the causes that stimulate pleasure or pain. So, again, to select another instance from Dr. Carpenter's enumeration, 'those involuntary movements of the body and limbs, excited by uneasy sensation, (probably muscular), which are commonly designated as the 'fidgets;''—this is exactly the description of an emotional outburst or expression of pain, like a start, or a groan, or a puckered countenance. He goes on to say, 'when the reflex activity of the sensory ganglia is more strongly excited, in consequence either of an unusual potency of the sensory impressions [that is, the sensations or feelings], or of an unusual excitability of these nervous centres, a much greater variety of sensory-motor actions is witnessed.' In other words, as the impressions are stronger, the diffused excitement is greater. This happens, however, not in the case of any limited number or class of sensations, but under every possible emotion that can occur to the human mind. A feeling that produces a certain excitement when feeble, produces a stronger and more varied display by being made stronger; the fact being, that such display and such movements are a constituent element of feeling, a part of its embodiment in the human frame. 'The movements and cries of animals during a tempest' might be called sensori-motor actions; they are more properly termed, I think, the movements belonging to the emotional condition of the mind for the time being.

These movements incorporated in our constitution as a portion of the very fact of being conscious, (we are often said to be 'moved,' when it is only meant that an impression is made on the mind), may be called 'sensori-motor,' inasmuch as a sensation, when sufficiently powerful, always visibly stimulates them, rendering them, as it were, the return or response of the outward im-

Movements of the Pharynx, Gullet, and Intestines for propelling the food in its course through the system. There is a pre-established connexion between the consecutive acts in these various functions, such that when one movement is completed, this brings on the next, and so on, without intermission. It is interesting to us, to find out to what lengths these pre-established arrangements are carried in the animal, and especially in the human, system. My object, all through the present chapter, is to ascertain what number of our actions grow out of primitive impulses of the muscular and nervous mechanism, in other words, what is the range or capability of the original structure of our being.

I regret to say that, on this subject, less assistance is to be derived from Physiologists than one would naturally have expected. Much has been written on the mechanism of animal movements, but I have not met with any writer that has aimed at separating the primitive tendencies from the acquired. Thus, for example, while the locomotive action has been most abundantly analysed, no attempt has been made to settle how

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pression. They may also be styled 'reflex,' for the very same reason. They are, farther, 'involuntary' movements, being quite distinct from our volitional acts. But they are very far from being unconscious: they are, if I am not mistaken, inseparable from consciousness, being entwined with the conscious condition in the mechanism of our frame. When consciousness is feebly excited, so are they, so feebly that no visible manifestation results; when a stronger excitement is applied, they waken up in proportion. In a cultivated shape, they make the gesticulation and display that constitutes the usual expression or natural language of feeling, which no man and no people is devoid of, while some nations show it in a remarkable degree. The painter, sculptor, poet, actor, seize hold of these movements as the basis of artistic forms; and the interest of the human presence is greatly dependent on them, and on the attitudes that result from them.

If I am correct in supposing that these so-called 'sensori-motor' actions are the movements due to the state of feeling or emotion that a sensible stimulus kindles, then the cerebral hemispheres are essential to their manifestation. Indeed, the wonderful and various diffusion of active display, that any intense feeling seems to require, as the physical part of its essence, can hardly be operated without that intermedium of multifarious connexion between all parts of the frame, which the cerebrum, with its masses of white conducting fibres, appears to afford.

far the original structure of the nerve centres, determines the alternating movements of the limbs requisite for this function. It seems constantly assumed that, in the human subject at least, the power of walking is wholly acquired, like playing on the trumpet or handling a musket, an assumption that I feel myself compelled to dissent from for reasons to be presently adduced.

6. The *locomotive rhythm* involves all the arrangements that I regard as primitive, in the class of combined movements of succession, apart from those organic movements of heart, lungs, and intestines above alluded to. I shall therefore proceed to adduce the grounds for believing, that the combined movements of locomotion are original or instinctive.

(1.) The analogy of the inferior quadrupeds, is in favour of the existence of a germ of locomotive harmony of the limbs in man. The community of structure of the vertebrate type is sufficiently close, to involve such a deep peculiarity of the nervous system as this. That which nature has done for the calf, towards one of the essential accomplishments of an animal, is likely to be done in some degree for man. To equip a creature for walking erect would doubtless be far more difficult, and might surpass the utmost limits of the primitive structural arrangements ; but seeing that the very same alternation of limb enters into both kinds, and that nature gives this power of alternation in the one case, we may fairly suppose that the same power is given in the other also.

(2.) It is a matter of fact and observation, that the alternation of the lower limbs is instinctive in man. I appeal to the spontaneous movements of infancy as the proof. Mark a child jumping in the arms, or lying on its back kicking ; observe the action of the two legs, and you will find that the child shoots them out by turns with great vigour and rapidity. Notice also when it first puts its feet to the ground ; long before it can balance itself, you may see it alternating the limbs to a full walking sweep. It is in virtue of this instinctive alternation that walking is so soon possible to be attained. No other combination equally complex could be acquired at the end of the first year. Both a vigorous spontaneous impulse to move the lower limbs, and a rhythmical or alternating direction given to this impulse, are concerned in this very early acquisition. Let the attempt be made to teach a child to walk sidewise at the same age, and we should entirely fail for want of a primitive tendency to commence upon.

(3.) It has been already seen, that the cerebellum is probably concerned in the maintenance of combined or co-ordinated movements. It is proved that these movements can be sustained without the cerebral hemispheres, but not without the cerebellum. But that the cerebellum should be well developed in man, and yet not be able to effect those harmonized arrangements found in the inferior vertebrata, is altogether improbable.

Unless some mode of invalidating these facts can be pointed out, the reasonable conclusion will be, that there is in the human subject a pre-established adaptation for locomotive movements, which adaptation I shall now attempt to analyse.

7. First, it involves the *reciprocation* or vibration of the limb. Confining ourselves to one leg, we can see that this swings back and fore like a pendulum, implying that there is a nervous arrangement, such that the completed movement forward sets on the commencing movement backward, and conversely. The cerebellum, or some other centre, must be so connected with the two antagonizing classes of muscles, that when one class has completed a contraction, a stimulus shall be transmitted to a ganglionic mass with returning nerves to the other class, by which nerves these are stimulated in turn, and, on contracting, repay the act by reviving the operation of the first. The two antagonist sets of muscles concerned in walking, are chiefly members of the two great general divisions of flexor and extensor muscles. Every moving member must have two opposing muscles or sets of muscles attached to it, and between these the limb is moved to and fro at pleasure. Now the analogy of the limbs would justify us in supposing, that there is an organised connexion between antagonist muscles generally, so as to give spontaneously a

swinging or reciprocating movement to the parts; in other words, that when any member is carried to its full swing in one direction, there is an impulse generated and diffused towards the opposing muscles, to bring it back or carry it in the other direction. This impulse may be feeble, may be very unequal in different parts, or may be entirely overborne, but we must look upon it as a result of muscular and nervous organization. Of course this reaction will be most strongly brought out, on occasions when the commencing movement takes a wide and energetic sweep. Thus in a swing of the arm carried up so as to point perpendicularly upward, I think we may discern an impulse in the opposing muscles to come into play in order to bring it back. Every swinging motion, whether of arm, leg, trunk, head, jaw, if not entirely due to volition, which it would be difficult to prove, must be supported by an arrangement of the nature now described.*

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* On the antagonism of muscular movements generally, I quote the following statements from Müller:—

'There are groups of muscles opposed to each other in their action in almost all parts of the body. The extremities have flexors and extensors, supinators and pronators, abductors and adductors, and rotators inwards and rotators outwards. Frequently the opposed groups of muscles have different nerves. Thus the flexors of the hand and fingers derive their nervous fibrils from the median and ulnar nerves; the extensors theirs from the radial nerve; the flexors of the fore-arm are supplied by the musculo-cutaneous; the extensors by the radial nerve. The crural nerve supplies the nervous fibres for the extensors of the leg; the ischiadic those for the flexors. The perineal muscles, which raise the outer border of the foot, derive their nervous fibres from the perineal nerve; the tibialis posticus, which raises the inner border of the foot, is supplied by the tibial nerve. The circumstance of the convulsive motions in affections of the spinal cord being frequently such as to curve the body in a particular direction, shows that there must be something in the disposition of the nervous fibres in the central organs which facilitates the simultaneous excitement to action of particular sets of muscles, as the flexors, or extensors, &c.; although Bellingeri's opinion, that the anterior columns of the spinal cord serve for the motions of flexion, the posterior for those of extension, is based on no sufficient facts. Too much importance, however, must not be given to the above remark relative to distinct nerves supplying the different groups of muscles; it is not a constant fact. Sometimes the same nerve gives branches to muscles opposed in action; the ninth, or hypo-glossal nerve, supplies both the

I do not overlook the fact that, in certain cases, an antagonism not muscular occurs to bring about a returning vibratory impulse. Thus in walking there is a pendulous swing of the leg, arising out of mere mechanical causes. Like any other body hanging loose, the leg is really and truly a pendulum, and when thrown back begins to move forward of its own accord. Again, the extensor muscles, which maintain the body in an erect position, are antagonised by the weight of the parts; hence in dancing up and down, the downward movement may take place by simply relaxing the tension of the supporting muscles. In the same manner the jaw would drop of its own accord. We must also allow for the natural tendency to relax a muscle freely, after a great effort, whereby the ordinary tension of its antagonist coming into play would overpower it. It is difficult to say how much is due to this cause, or how far a muscle by being dilated to the full stretch is, by virtue of that circumstance, rendered more ready to contract, in other words, stimulated. But notwithstanding all these considerations, I feel compelled to suppose a specific arrangement in the nervous centres, for bringing about alternate movements of the class now described. We know such an arrangement to exist in the involuntary movements of the heart, lungs, and intestines, and we are therefore justified in interpreting similar tendencies to alternation among voluntary muscles on the same principle of mechanism.

8. Secondly, there is further applied in locomotion, an *alternate* movement of corresponding limbs, or an alternation of the two sides of the body. After one leg has made its forward sweep, an impulse must be given to the other leg to commence a movement in the same course. The two sides of

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muscles which draw the hyoid bone forwards, and one muscle which retracts it; the perineal nerve supplies the perineal muscles, which raise the outer border of the foot, and the tibialis anticus, which opposes this motion. Antagonist muscles can, moreover, be most easily made to combine in action; thus the perineal muscles and the anterior tibial, acting together, raise the foot. The flexor carpi radialis and the extensor carpi radialis can combine so as to abduct the hand.'—p. 925.

the body must be so related, thut the full stretch of the muscles of the one side originates a stimulus to those of the other. Nothing less would suffice to enable a new-born calf to walk. The alternation between the right and left legs, both fore and hind, must be firmly established in the animal's organization by a proper arrangement of the nerves and nerve centres. And if the power of walking in human beings be assisted by primitive impulses and arrangements, this specific provision is necessarily implied. The commissural nervous connexions between the two sides, in the spinal cord, medulla oblongata, cerebellum, &c., will have to transmit indications from one side to the other with the view of bringing on the due rhythm or alternation of right and left members.

The alternation of the two sides in locomotion extends much beyond the muscles of the limbs ; the whole trunk and head sway in harmony with the members, both in quadrupeds and in man.

There are some important exceptions to this alternating arrangement, but these are of a kind to place in a stronger light the examples of it now quoted. The two eyes are made to move together, and never alternate. This too demands an express commissural connexion of the nerve centres, even more decided than the other case. No question can arise about this being a primitive fact of the mechanism; the arrangement is the most prominent, but not the only, example of associated *simultaneous* movements, depending on the structure of the nerve centres. It has doubtless much to do with the unity and singleness of the act of vision. If also we observe the early movements of the arms in children, we shall find in them more of the tendency to act together than to alternate, showing, as we might otherwise infer, that the impulse of alternation of the limbs is not so deep-seated an instinct in man as in quadrupeds. In like manner, the movements of the features are for the most part the same on both sides of the face. Both classes of facts must proceed upon commissural nervous connexions, but while in some cases the one kind of connexion seems to prevail, the alternating, in the others the associating connexion is strongest.

9. Thirdly. The locomotion of animals moving on all fours suggests a further necessity of primitive adjustment. It is requisite that there should be some provision, for keeping the fore and hind legs in proper relation and rhythm. Something of the nature of the *vermicular* movement, (that is, the locomotion of worms) or the movements of the alimentary canal, would need to be assumed in this case. Such a connexion must exist between the fore and hind segments, in order that the movements of the one may stimulate in succession the movements of the other, by a nervous propagation along the spinal cord to the cerebellum, or other centre governing the instinctive rhythmical motions. In the crawling of reptiles, it is obvious that the muscular contraction in one segment or circle, must yield a stimulus to a nerve in connexion with the next circle, which is made to contract in consequence, and furnish a stimulus to the third, and so on through the whole line of the body: the action of the intestines being precisely the same. I cannot conceive how quadrupeds could walk as they do, without a provision of a similar kind. In a dog, we see the movement of the limbs propagated to the tail. Each species of animal has its particular formula of ordering the legs in walking, determined it may be in part by the shape of the body, but duly transmitted in the breed as a property of its structure. The shamble of the elephant represents one species of rhythm, while the horse can pass through all the varieties of walk, gallop, and canter. In climbing, too, the alternation and the propagation each come into play as helps. In swimming, both are likewise apparent.

10. I must now mention more particularly the *associated* or consensual movements, or those that are so connected as to act together. Here we need an organization of a different kind. The combining or associated muscles have to be supplied with a common nerve, so that the stimulus of one is a stimulus of the whole group that are in union. The most

perfect example of this is the Eye. In order to make the two eyes act together, the corresponding muscles of each must be simultaneously excited by the nerves. The following are the facts connected with this interesting case. I quote again from Müller.

'Some of the most remarkable facts illustrating the association and antagonism of muscular actions, are presented by the muscles which move the eyes. The corresponding branches of the third, or motor oculi, nerve of the two sides have a remarkable innate tendency to consensual action, a tendency which cannot be ascribed to habit. The two eyes, whether moved upwards, downwards, or inwards, must always move together; it is quite impossible to direct one eye upwards and the other downwards at the same time. This tendency to consensual action is evidenced from the time of birth; it must therefore be owing to some peculiarity of structure at the origins of the two nerves. The association in action of the corresponding branches of the two nervi motores oculi, renders the absence of such tendency to consensual motion in the two external recti muscles and the sixth nerves more striking. We do, it is true, in a certain measure cause the two external recti muscles to act together when we restore the two eyes, of which the axes are converging, to the parallel direction; but there the power of consensual action ends; the two eyes can never be made to diverge, however great the effort exerted to do so. There is an innate tendency and irresistible impulse in the corresponding branches of the third nerve to associate action; while in the sixth nerves not only is this tendency absent, but the strong action of one of these nerves is incompatible with the action of the other. These innate tendencies, in the third and sixth nerves, are extremely important for the functions of vision: for if, in place of the sixth nerves, the external recti muscles had received each a branch of the third nerve, it would have been impossible to make one of these muscles act without the other; one eye, for example, could not have been directed inwards while the other was directed outwards, so as to preserve the parallelism, or convergence of their axes, but they would necessarily have diverged when one rectus externus had been made to act voluntarily. To render possible the motion of one eye inwards, while the other is directed outwards, the external straight muscles have received nerves which have no tendency to consensual action. In consequence, however, of the tendency in the two internal straight muscles to associate motion, it is necessary when one eye is directed inwards and the other outwards, that the contraction of the rectus externus of the latter should be so strong as to overcome the associate action of the rectus internus of the same eye; and in the effort to direct one eye completely outwards, we actually feel this stronger contraction of the external rectus. These considerations enable us to understand perfectly the hitherto enigmatical fact that, in all vertebrata, the external rectus muscle receives a special nerve.' (p. 929.)

The author then goes on to show the relation of the corresponding oblique muscles to each other, and the similar reason there is for having distinct nerves to the superior oblique or tróchlear muscle.

An association exists between the adjustment of the iris and the other movements of the eye; thus, whenever the eye is voluntarily directed inwards, the iris contracts. This brings about the fact already stated, that the iris is contracted during near vision.

Müller also remarks that 'the motions very prone to be associated involuntarily, are those of the corresponding parts of the two sides of the body. The motion of the irides, of the muscles of the ear, of the eyelids, and of the extremities, in the attempt to effect opposed motions, are examples of such associations.' I have already remarked that this coincidence of movements on the two sides, co-exists, in the case of the limbs at least, with an organization for an alternating motion.

The same author further observes, that 'the less perfect the action of the nervous system, the more frequently do associate members occur. It is only by education, that we acquire the power of confining the influence of volition, in the production of voluntary motions, to a certain number of nervous fibres issuing from the brain. An awkward person, in performing one voluntary movement makes many others, which are produced involuntarily by consensual nervous action.' (p. 928.) This, however, introduces much larger considerations, involving the whole mechanism of emotion and volition and cannot be done justice to in the present connexion.

11. There are various appearances that suggest the existence of a law of general *harmony* of state throughout the muscular system. In stretching the lower limbs we feel at the same time an impulse to stretch the arms, the trunk, the head, and the features, or to put in action the whole class of extensor or erector muscles. The act of yawning propagates a movement over the whole body. I cannot positively affirm that this may not be explained by similarity of state producing everywhere a similar impulse, but the appearances are more in favour of a certain organized connexion that operates in producing a harmony of condition. When the eye is gazing attentively on an object, the whole body is spontaneously arrested, the features are fixed, the mouth is open; the same harmonizing fixity is observed in the act of listening. So a movement in one part propagates itself to other parts, unless a special check is maintained. The movements of the eye excite the whole body. Vocal utterance brings on gesticulation. The *pace* of movement is also rendered harmonious. Rapid movements of the eye from exciting spectacles make all the other movements rapid. Slow speech is accompanied by languid gestures. In rapid walking, the very thoughts are quickened.

I feel a difficulty in classing these movements with the foregoing, on account of the emotional element that is present in them, rendering them more probably a portion of the complex fact of emotion. The other movements may be cerebellar, these are more likely to be cerebral. Nevertheless, although they are connected with feeling, they are to be ranked among the primitive impulses that serve the useful ends of the animal; they count among the *practical* instincts now under discussion. They cause the animal to come into harmony with the circumstances that surround it,—to be quiet when the scene is still, to start up and join the chase when others are stirring.

This property imparts character to individuals. A person is either slow, or vivacious, generally ; the cast of movement is the same in all organs, in action and in thought. From it arises, likewise, a means of rousing and controlling the actions, thoughts, and passions of men and animals.

12. There are certain primitive links between different sensations that deserve to be noticed, in an attempt, like the present, to set forth all that is instinctive in the animal constitution. I refer to those cases, where one sense can apparently act for another previous to experience, as when an animal detects wholesome or unwholesome food by the smell, before tasting it. That the sense of taste should act to inform us of what is good for digestion (which it does to an imperfect degree in the human subject), is not surprising, seeing that, in the mouth, the alimentary canal is already commenced ; we feel more difficulty in discovering, how *smell* should have this power of anticipating digestion and nutrition.

The effluvia that bodies emit to the nostrils, may be a specimen or representative of their substance as applied to the stomach, and may have something of a like effect on the nervous system. We know that the smell of putridity causes loathing and disgust, and that an attempt to eat such material would only complete the effect already begun ; while, on the other hand, substances that have a fresh or sweet flavour, would in all probability be free from nausea in the stomach.

On the general fact of one sense acting for another by way of warning or invitation, it is to be remarked that a deep harmony appears to exist among the different senses, in consequence of which we apply common epithets to the objects of all of them. Thus the effect we call 'freshness,' determined by the stimulus of the lungs, the digestion, or the general nervous tone, arises in several of the senses. The difficulty is to find the *same external object,* acting in the same manner upon two or more of them, as in the case of discerning food by the sight, or by the smell. I am disposed to think, that these coincidences recognised before experience are very few in number, and that the great safeguard of animals lies in making the direct experiment of eating what comes in their way, and deciding according to the feelings that result therefrom.*

OF THE INSTINCTIVE PLAY OF FEELING.

13. In following out our present object, which is to pass in review all that is primitive among the impulses and susceptibilities of the mental system, some account must be given of the instinctive or original mechanism for the expression of Feeling.† It is well known that some of the most conspicuous among the manifestations of human feeling, as Laughter and Tears, belong to us from our birth. Education here finds work in repressing original impulses, no less than in imparting new and artificial forms of emotional display.

It will be convenient to extract entire the section devoted to this subject in Müller's *Physiology.* The professed title of the section is, *Movements due to the Passions of the Mind.*

'It is principally the respiratory portion of the nervous system which is involuntarily excited to the production of muscular actions by passions of the mind. Here again we see that any sudden change in the state of the brain, propagated to the medulla oblongata, immediately causes a change of action in the respiratory muscles, through the medium of the respiratory nerves, including the respiratory nerve of the face. There are no data for either proving or

* It is a fact that lambs commence eating, not the short tender grass, but the long and dried tops.

† I have already referred (see § 4 of this chapter, and p. 264), to the general law which I believe connects together emotion, or feeling, and those physical activities of the frame known as the expression or manifestation of feeling. The movements and display caused by mental excitement have been generally regarded as merely incidental to certain of the stronger feelings, and little attention has been paid to them in the scientific consideration of the mind. For my own part, however, I look upon these active gestures as a constituent part of the complex fact of consciousness, in every form and variety. I do not say but that we may have feelings that do not give rise to any visible stir of the active members, either in consequence of voluntary suppression, or because the diffused stimulus is too weak to overcome the inertia of the parts to be moved,—but I mean to affirm that, with feeling, there always is a freely diffused current of nervous activity, tending to produce movements, gesture, expression, and all the other effects described in the course of the next few pages.—See The Emotions and the Will, p. 5.

refuting the hypothesis, that the passions have their seat of action in a particular part of the brain, whence their effects might emanate. But these effects are observed to be transmitted *in all directions** by the motor nervous fibres, which, according to the nature of the passion, are either excited or weakened in action, or completely paralysed for the time.

'The exciting passions give rise to spasms, and frequently even to convulsive motions affecting the muscles supplied by the respiratory and facial nerves. Not only are the features distorted, but the actions of the respiratory muscles are so changed as to produce the movements of crying, sighing, and sobbing. Any passion of whatever nature, if of sufficient intensity, may give rise to crying and sobbing. Weeping may be produced by joy, pain, anger, or rage. During the sway of depressing passions, such as anxiety, fear, or terror, all the muscles of the body become relaxed, the motor influence of the brain and spinal cord being depressed. The feet will not support the body, the features hang as without life, the eye is fixed, the look is completely vacant and void of expression, the voice feeble or extinct. Frequently the state of the feelings under the influence of passion is of a mixed character; the mind is unable to free itself from the depressing idea, yet the effort to conquer this gives rise to an excited action of the brain. In these mixed passions the expression of relaxation in certain muscles,—in the face, for example,—may be combined with the active state of others, so that the features are distorted, whether in consequence merely of the antagonising action of the opposite muscles being paralysed, or by a really convulsive contraction. Frequently also, both in the mixed and the depressing passions, some muscles of the face are affected with tremors. The voluntary motion of a muscle half paralysed by the influence of passion is frequently of a tremulous character, in consequence of its being no longer completely under the influence of the will. We experience his particularly in the muscles of the face, when, during the sway of a depressing or mixed passion, we endeavour to excite them to voluntary action; the muscles of the organ of voice also, under such circumstances, tremble in their action, and the words attempted to be uttered are tremulous.

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* Italics mine.

'The nerve most prone to indicate the state of the mind during passion is the facial;* it is the nerve of physiognomic expression, and its sphere of action becomes more and more limited in different animals, in proportion as the features lose their mobility and expressive character. In birds, it has no influence on the expression of the face; those only of its branches exist which are distributed to the muscles of the hyoid bone and the cutaneous muscle of the neck; and the erection of the skin of the neck, or, in some birds, of the ear feathers is in them the only movement by which the facial nerve serves to indicate the passions. Next to the facial, the respiratory nerves,—those of the internal organs of respiration, the laryngeal and phrenic nerves,† as well as those of the external thoracic and abdominal muscles—are most susceptible of the influence of the passions. But when the disturbance of the feelings is very intense, all the spinal nerves become affected, to the extent of imperfect paralysis, or the excitement of trembling of the whole body.

'The completely different expression of the features in different passions shows that, according to the kind of feeling excited, entirely different groups of the fibres of the facial nerve are acted on. Of the cause of this we are quite ignorant.

'The disturbed action of the heart during mental emotions is a remarkable instance of the influence of the passions over the movements of organs supplied by the sympathetic nerve.'—p. 932-4.

14. With regard to the Movements of the Face, Sir Charles Bell is of opinion, that many of them are secondary to the movements of respiration. He considers the heart and lungs as the great primary source of expression, the organs first affected by the emotional excitement of the brain.

He calls attention to 'the extent of the actions of respiration; the remoteness of the parts agitated in sympathy with the heart. The act of respiration is not limited to the trunk; the actions of certain muscles of the windpipe, the throat, the lips, the nostrils, are necessary to expand those tubes and openings, so that the air may

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* 'The *facial* nerve is the motor nerve of the face. It is distributed to the muscles of the ear and of the scalp; to those of the mouth, nose, and eyelids; and to the cutaneous muscle of the neck.'

† The *laryngeal* nerves are distributed to the different parts of the larynx, and are, therefore, instrumental in stimulating the voice. The *phrenic*, or diaphragmatic nerve, is the special nerve of the diaphragm.

be admitted through them in respiration with a freedom corresponding to the increased action of the chest. Without this, the sides of these pliant tubes would fall together, and we should be suffocated by exertion or passion. Let us consider how many muscles are combined in the single act of breathing—how many are added in the act of coughing—how these are changed and modified in sneezing; —let us reflect on the various combinations of muscles of the throat, windpipe, tongue, lips, in speaking and singing,* and we shall be able justly to estimate the extent of the muscles which are associated with the proper or simple act of dilating and compressing the chest. But how much more numerous are the changes wrought upon these muscles when nature employs them in the double capacity of communicating our thoughts and feelings; not in the language of sonnds merely, but in the language of expression of the countenance also; for certainly the one is as much their office as the other.'

'Let us see how the machine works. Observe a man threatened with suffocation: remark the sudden and wild energy that pervades every feature; the contractions of his throat, the gasping and the spasmodic twitchings of his face, the heaving of his chest and shoulders, and how he stretches his hand and catches like a drowning man. These are efforts made under the oppressive intolerable sensation at his heart; and the means which nature employs, to guard and preserve the animal machine, giving to the vital organ a sensibility that excites to the utmost exertion.'—*Anatomy of Expression*, 3rd Edition, p. 91.

This last illustration does not decide the point as to the dependence of the contortion of the features upon the respiratory organs, inasmuch as the state of intense pain supposed would excite every part of the body by direct action. The previous remarks on the necessity there is for movements of the respiratory passages,—the throat, mouth, and nostrils,—to accompany the action of the lungs, are very much in favour of the author's view.

But that the action on the face is not wholly a consequence of respiratory excitement, is decisively proved by the expres-

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* These, however, are not primitive or instinctive associations, the class we are most interested in tracing out at present.

sion of the eyes, for this in no way ministers to the breathing function. We are, therefore, bound to presume that while a certain amount of the facial expression is due to the sympathy or association of the parts with the movements of the lungs, there still remains a source of independent excitement derived from the brain at first hand, and by the same common impulse that affects the respiratory, the vocal, and other organs. This distinctness of action is recognised in the passage above quoted from Müller.

15. In tracing out systematically and minutely the physical accompaniments of states of feeling, there is observable a broad and fundamental division into two classes, namely, effects of *movement* through the muscular system; and *organic* effects, or the influences exerted upon the viscera and glandular organs. Let us first consider the Movements. We find certain muscles more especially acted on under feeling, and named for that reason muscles of Expression. Of those more susceptible regions, our attention is first called to the *Face*.

The muscles of the face, whereby all the movements are sustained, are arranged round three distinct centres,—the mouth, the nose, and the eyes. The mouth has the largest number of muscles, and is the most easily affected by states of feeling. The nose is the least endowed with mobility.

The muscles of the Eyebrow have been already pointed out. The *occipito-frontalis* descends over the forehead, and is inserted into the eyebrow; this it raises or arches; it is opposed by the *corrugator supercilii*, which corrugates or wrinkles the forehead, drawing the eyebrows together. These are pre-eminently muscles of expression, although also employed as voluntary muscles for the purposes of vision. They are emotionally moved by opposite states of feeling, the one in the more pleasing emotions, the other in pain, doubt, and embarrassment; and the appearance they cause to a spectator comes to suggest, by association, the corresponding states of mind. The *orbicular muscle* of the eyelids, which closes the eye, is of the nature of a sphincter, like the muscle surrounding the mouth and constituting the lips. This is opposed by the *levator palpebræ*, or the elevating muscle of the upper eyelid, which opens the eye, both voluntarily and under emotion. The *tensor tarsi* 'is a very thin, small muscle, placed at the inner side of the orbit, resting against the fibrous covering of the lachrymal sac and behind the tendon of the orbicularis.'

'The corrugator muscle, being fixed at its inner extremity, draws the eyebrow and eyelid inwards, and throws the skin into perpendicular lines or folds, as in frowning. The occipito-frontalis will, on the contrary, elevate the brow, and wrinkle the skin transversely; which actions are so frequently repeated by most persons, and so constantly by some of a particular temperament, that the skin is marked permanently by lines in the situations just referred to. The orbicular muscle is the sphincter of the eyelids. It closes them firmly, and at the same time draws them to the inner angle of the orbit, which is its fixed point of attachment. The levator palpebræ is the direct antagonist of the orbicular muscle; for it raises the upper eyelid, and uncovers the globe of the eye. The tensor tarsi draws the eyelids towards the nose, and presses the orifices of the lachrymal ducts close to the surface of the globe of the eye. It may thus facilitate the entrance of the tears into the ducts, and promote their passage towards the nose.'—QUAIN, Vol. ii. p. 9.

16. The muscles of the Nose are, first, the *pyramidal*, 'which rests on the nasal bone, and appears like a prolongation of the occipito-frontalis, with whose fibres it is intimately connected. It extends from the root of the nose to about half-way down, where it becomes tendinous, and unites with the compressor naris. Its chief effect seems to be that of giving a fixed point of attachment to the frontal muscle: it also wrinkles the skin at the root of the nose.'

The *common elevator of the lip and nose* lies along the side and wing of the nose, extending from the inner margin of the orbit to the upper lip. It raises the wing of the nose and the upper lip together.

The *compressor naris* 'is a thin, small triangular muscle, which lies close upon the superior maxilla and the side of the nose, being transverse from without inwards and upwards.' Contrary to its name, the principal action of it must be to expand the nostril by raising the lateral cartilage. This is an action in obvious harmony with respiration, seeing that it opens the nasal passage.

The *depressor alæ nasi* 'is a small flat muscle, lying between the mucous membrane and the muscular structure of the lip, with which its fibres are closely connected.'

Of these and other bundles of muscular fibres, traceable on the small cartilages of the nose, the only considerable or powerful muscle is the common elevator of the lip and nose, which is thoroughly under the command of the will, and produces a very marked contortion of feature, wrinkling the nose and raising the upper lip. In expressing disgust at a bad smell, this muscle is very readily brought into play, and thence it comes to be employed in expressing disgusts generally. It is, however, employed without any such intention.

17. There are ten muscles connected with the movements of the Mouth. One of them, the *orbicularis*, is single, and surrounds and forms the aperture itself, the other nine are pairs, and radiate from this as from a centre.

The *proper elevator of the upper lip* extends from the lower border of the orbit to the upper lip, lying close to the border of the common elevator of lip and nose. When the lip is raised without raising the nose, which is not a very easy act, this muscle is the instrument.

The *elevator of the angle of the mouth* 'lies beneath the preceding, and partly concealed by it.'

'The *zygomatici* are two narrow fasciculi of muscular fibres, extending obliquely from the most prominent point of the cheek to the angle of the mouth, one being larger and longer than the other.' The elevator of the angle of the mouth, and the zygomatic muscles, serve to retract the angle of the mouth in *smiling;* they are therefore *muscles of expression.*

The two former of these four muscles are concerned in raising the upper lip, but they do not act very powerfully, or conspicuously. In fact, the upper lip is a feature remarkable for fixity, as compared with the under lip, and is not often elevated in man, and, on the occasions when it is raised, this is done by the common elevator rather than by its own proper muscles.

The region of the lower jaw contains three muscles, the depressor of the angle of the mouth, the depressor of the lower lip, and the elevator of the lower lip.

The *depressor of the angle of the mouth* lies at the side and lower part of the face, being extended from the angle of the mouth to the lower jaw.

The *depressor of the lower lip* is a small square muscle, lying nearer to the middle line of the chin than the preceding, by which it is partly concealed. It arises from the fore part of the lower jaw-bone, and is inserted into the lower lip, its fibres becoming blended with those of the orbicular muscle of the mouth, having been previously united with those of its fellow on the opposite side.

The *elevator of the lower lip* arises from a slight pit below the teeth-sockets of the lower jaw, near the middle line of the jaw, and is inserted into the tegument of the chin, which it lifts when in action.

The remaining muscles of the mouth are unconnected with either jaw, having a sort of middle position between them.

'At each side of the face, in the part called the 'cheek,' is a muscle—the *buccinator;* and, round the margin of the mouth, one—the *orbicularis oris.*'

'The *buccinator* is a thin, flat plane of muscular fibres, quadrilateral in figure, occupying the interval between the jaws.' This muscle is exerted in masticating the food, and receives nerves from the same source as the masseter, which is one of the principal muscles engaged in the act of mastication.

The *orbicularis oris* 'belongs to the class of sphincter muscles, and like them is elliptic in form, and composed of concentric fibres, so placed as to surround the aperture of the mouth, but with this peculiarity, that the fibres are not continued from one lip into the other. The muscle is flat and thin; its inner surface being in contact with the coronary artery of the lips, labial glands, and the mucous membrane; the external with the skin and the fibres of the different muscles which converge towards the margin of the mouth.'

'The aperture of the mouth is susceptible of considerable dilatation and contraction; the former being affected by the different muscles which converge to it, and which may be compared to retractors drawing, with different degrees of obliquity, the lips, or their angles, in the direction of their respective points of attachment. The elevators are necessarily placed at the upper part of the face, the depressors in the opposite situation, and the proper retractors on each side; and these are the zygomatici and the buccinators. The buccinators also contract and compress the cheeks; this power is brought into play when any substance becomes lodged in the interval between them and the jaws.'

18. But it would be a mistake to confine the wave of movement to the Face, although this is the region where it is pre-eminent. The voice acts in concert, giving forth sounds that are characteristically different under joy or woe, affection or rage. (The mechanism of the vocal organs is described in a separate section.) Among muscles specially affected under mental states, we should not omit the Diaphragm.

All the muscles of the body may be thrown into agitation under a wave of strong feeling; the movements, gesticulations, and carriage of the frame at any one moment are confidently referred to as proof of a certain emotional state. In joyful moods, an abundance of gesticulation is often displayed in company with the play of the features and the voice. In sorrow, there is sometimes a wild frantic excitement, but more commonly we observe the inaction and collapse of the moving members generally. In Wonder, there is apt to be a liveliness of movement; so in Rage; while a tremulous quaking is the characteristic of Fear.

19. I must next advert to the Organic effects of emotion, which are quite equal in point of importance to the muscular. The viscera and glandular organs that are known to be the most decisively acted on are the following:—

(1.) The *Lachrymal Gland* and *Sac.* The Anatomy of this part has been adverted to in speaking of its associated organ, the Eye. The effusion of Tears from the gland is constantly going on during waking hours. Certain states of emotion,—tenderness, grief, excessive joy—cause the liquid to be secreted and poured out in large quantities, so as to moisten the eye, and overflow upon the cheek. By this outpouring a relief is often experienced under oppressive pain, the physical circumstance being apparently the discharging of the congested vessels of the brain. A strong sensibility undoubtedly lodges in the lachrymal organ, the proof of a high cerebral connexion. The ordinary and healthy flow of this secretion, when conscious, is connected with a comfortable and genial feeling; in the convulsive sob, not only is the quantity profuse, but the quality would appear to be changed to a strong brine.

(2.) The *Sexual Organs.* These organs are both sources of feeling when directly acted on, and the recipients of influence from the brain under many states of feeling otherwise arising. They are a striking illustration of the fact that our emotions are not governed by the brain alone, but by that in conjunction with the other organs of the body. No cerebral change is known to take place at puberty; nevertheless, a grand extension of the emotional susceptibilities takes place at that season. Although the organs may not receive their appropriate stimulation from without, the mere circumstance of their full development, as an additional echo to the nervous waves diffused from the cerebrum, alters the whole tone of the feelings of the mind, like the addition of a new range of pipes to a wind instrument. It is the contribution of a *resonant* as well as a sensitive part.

(3.) The *Digestive Organs.* These have been already fully described; and their influence upon the mental state has also been dwelt upon. In the present connection, we have to advert more particularly to the reciprocal influence of the mind upon them. It may be doubted if any considerable emotion passes over us without telling upon the processes of digestion, either to quicken or to depress them. All the depressing and perturbing passions are known to take away appetite, to arrest the healthy action of the stomach, liver, bowels, &c. A hilarious excitement within limits, stimulates those functions; although joy may be so intense as to produce the perturbing effect; in which case, however, it may be noted that the genuine charm or fascination is apt to give place to mere tumultuous passion.

The influence of the feelings in Digestion is seen in a most palpable form in the process of salivation. In Fear, the mouth is parched by the suppression of the flow of the saliva: a precise analogy to what takes place with the gastric juice in the stomach.

An equally signal example in the same connexion is the choking sensation in the throat during a paroxysm of grief. The muscles of the pharynx, which are, as it were, the beginning of the muscular coat of the alimentary canal, are spasmodically contracted, instead of alternating in their due rhythm. The remarkable sensibility of this part during various emotions, is to be considered as only a higher degree of the sensibility of the intestine generally. The sum of the whole effect is considerable in mass, although wanting in acuteness. In pleasurable emotion even, a titillation of the throat is sometimes perceptible.

(4.) The *Skin*. The cutaneous perspiration is liable to be acted on during strong feelings. The cold sweat from fear or depressing passion, is a sudden discharge from the sudorific glands of the skin. We know, from the altered odour of the insensible or gaseous perspiration during strong excitement, how amenable the functions of the skin are to this cause. It may be presumed, on the other hand, that pleasurable elation exerts a genial influence on all those functions.

A precisely similar line of remarks would apply to the *Kidneys*.

(5.) The *Heart*. The propulsive power of the heart's action varies with mental states as as well with physical health and vigour. Some feelings are stimulants to add to the power, while great pains, fright, and depression may reduce the action to any extent. Müller remarks above, that the disturbance of the heart is a proof of the *great range* of an emotional wave; or its extending beyond the sphere of the cerebral nerves to parts affected by the sympathetic nerve.

(6.) The *Lungs*. This, according to Bell, is the organ pre-eminently acted on. Now, although this exclusiveness is untenable, yet there can be no question as to the great extent of sympathy between the respiratory movements and the feelings. A moderate change of mental tone will sensibly elevate or depress the vigour of respiration no less than the physical change to good or bad air; and extreme states of excitement are associated with the convulsive states of laughing and sobbing, which are both connected with the respiratory organs; the one producing a violent acceleration of the process, the other spasmodically checking it.

(7.) The *Lacteal Gland* in women. Besides the six organs now enumerated as common to the two sexes, we must reckon the speciality of women, namely, the Secretion of the Milk. As in all the others, this secretion is genial, comfortable, and healthy, during some states of mind, while depressing passions check and poison it. As an additional seat of sensibility, and an additional resonance to the diffused wave of feeling, this organ might be expected to render the female temperament a degree more emotional than the male, especially after child-bearing has brought it into full play.

20. The question now presents itself: can any principle be assigned as giving a clue to this complicated blending of physical effects with states of feeling?

A very considerable number of the facts may be brought under the following principle, namely, that *states of pleasure are connected with an increase, and states of pain with an abatement, of some, or all, of the vital functions.*

Let us first revert to the known Agents, or stimulants, of pleasurable feeling, and compare them with their opposites. Beginning with the muscular Feelings, it is known that exercise is pleasurable only when we are expending surplus nergy, and thereby making the blood to course through the ystem more rapidly. Both the heart and the lungs are uickened by bodily exercise, while an accumulation of force, vhich it would be painful to restrain, finds a vent. Let the tage of fatigue, however, be reached, and let the spur to exer- ion be still continued, we then witness the concurring cir- umstances of the sense of pain, and the lowering of vital nergy. When exercise is prolonged to the point of painful atigue, there is an actual diminution in the amount of carbonic cid given off by the lungs, showing an enfeebled respiration. The action of the heart is likewise enfeebled, and thus upon wo vital organs an abatement of energy has fallen. It is qually certain that the digestive power is reduced under the ame circumstances.

Then, as to Muscular Repose, a feeling highly pleasurable, specially if the amount of exercise has been well adjusted to he strength, the generalization is not less applicable. What appens in resting after exertion is evidently this. The uscles have expended all their surplus energy, and in so oing have stimulated several of the vital functions, such as he Heart, the Lungs, and the Skin. The Digestive function not directly quickened under exercise, but rather retarded y the concentrating of the nervous currents in the muscles. till much good has been effected by the exalted operation of ese other organs; and now at the stage of repose, the power itherto compelled into one exclusive direction, being set free, turns to the other parts, and especially to the Digestive nctions, whose exaltation through that circumstance co- cides with the pleasant sensibility of the resting posture. he muscular tissue is also in a state for assimilating nutri- ent, which process was incompatible with the active con- tion. Thus, while in Repose we have the cessation of one tal energy, a corresponding accession is made to several hers: the organic functions generally are heightened, as ental and bodily activities subside.

As to the Sensations of Organic Life, commentary is al- ost superfluous. There are but few seeming exceptions to the rule, that organic pains are connected with the loss of power in some vital function, and organic pleasures with the opposite. Wounds, hurts, diseases, suffocation, thirst, hunger, nausea, are so many assaults upon our vitality. Taken in the gross, there can be no dispute as to the general tendency. As to the exceptions, the study of them, in some instances at least, serves to elucidate the principle. Cold is a painful agent, yet we know that it increases the functional activity of the muscles, the nerves, the lungs, and the digestion, depressing only one organ, the skin. We may hence infer that the skin is an organ of greater sensibility than any of these others. The stimulation is sometimes obtained without the depression, as in the reaction after a cold bath when the skin recovers its tone ; the whole effect is then exhilarating.

Another apparent exception is the occasional absence of all pain in the sick bed, and the happy elation sometimes shown in the last moments of life. These cases prove, what we are already prepared for, by the example of muscular repose already cited, that a high condition of *all* the vital functions is not necessary to agreeable sensibility, and opens up the important enquiry, which of these functions are most connected with our happiness, and which least ? It is clear that great muscular energy, exerted or possessed, is not an immediate essential, although an indirect adjunct of considerable value. It is equally clear that the power of digestion, and a certain degree of animal heat, are indispensable. There are states of inanition, of indigestion, and of chillness, that would sink the loftiest spirit into despair. Thus it may be, that the comfort of the bed-ridden patient, and the placidity of the dying moments, are in a measure due to the fact, that disease has overtaken chiefly the functions that least participate in our sensitive life. Painless extinction is in this way contrasted with suffering continued through a long life. There are parts whose derangement is not felt till on the eve of a fatal issue ; there are others that cannot be impaired without making the fact known, and that may work ill for many years before causing death. Even the organs most conected with mind, next to the brain, may undergo morbid hanges that do not prevent them from giving their usual enial response to a pleasurable wave. Obstructed bowels rill quench more happiness than certain kinds of organic isease of the intestines. The lungs are sometimes at the ast stage of decay before affecting the enjoyment of the atient; while the healthiest man is alive to the distress of artial suffocation.

When we pass from the Organic Feelings to the Sensa-ons of the five senses, we miss the same decided coincidences. n Taste and Smell, for example, the rule might hold in those ensations that involve important vital organs as the Stomach nd the Lungs, but scarcely with the proper sensibilities of ne senses. A taste merely sweet, without being a relish, ves pleasure; but we cannot, in this instance, assign any narked increase of vital function. A bitter taste can even perate as a tonic. So with odours. We have sweet odours nat are sickly, in other words, depressing; and although ome of the mal-odours may lower the vital power, this does ot always happen, and there is no proportion between the ain and the lowering of the functions.

Soft and agreeable touches have an effect on the mind omewhat analogous to agreeable warmth; but we cannot ttribute the same physical consequences to the one as to the ther. On the other hand, the painful smart, far from diminis-ing the energies, rather excites them for a time at least; so nat here too the induction would appear to fail.

The pleasures of Hearing and Sight are probably accom-anied with increased vital energy to some extent. When a erson is brought from confinement in the dark to the light day, there is observed a rise in the pulsation and in the reathing, which is so far in favour of the general doctrine. ut we cannot contend, that the degree of augmented vital nergy corresponds always with the degree of the pleasure. n short, the principle that served us so well in summing up ost of the organic pleasures and pains, does not apparently old in the five senses. Some additional mode of action must be sought for, in order to give a complete theory of pleasure and pain. But before enquiring into this supplementary law, let us complete the survey of the facts bearing upon the one already announced, by viewing the accompaniments of feeling under another aspect.

21. Hitherto we have considered the physical *agents* of pleasure or pain, and have ascertained that in a number of cases, these are agents of bodily exaltation or depression. This does not exhaust the evidence. Another set of proofs is furnished by studying the *manifestations* under the opposing mental conditions, which will bring under review other pleasures and pains besides those arising from the Senses.

What, then, is the universally observed expression of pleasure, no matter how originating? Can it be better described than in the synonymes of the word pleasure,—such epithets as lively, animated, gay, cheerful, hilarious, applied to the movements and expression,—all tending to suggest that our energies are exalted for the time. In joyful moods, the features are dilated; the voice is full and strong; the gesticulation is abundant; the very thoughts are richer. In the gambols of the young, we see to advantage the coupling of the two facts—mental delight, and bodily energy. Introduce some acute misery into the mind at that moment, and all is collapse, as if we had struck a blow at the heart. (I leave out of account at present the one form of uproarious and convulsive grief). A medical diagnosis would show, beyond question, that the heart and the lungs were lowered in their action just then; and there would be good grounds for inferring an enfeebled condition of the digestive organs.

But we can be more particular in our delineation. The expression of the face has been completely analysed by Sir Charles Bell. In pleasing emotions, the eyebrows are raised and the mouth dilated, the whole effect being to open up the countenance; in painful emotions, the corrugator of the eyebrow acts according to its name; the mouth is drawn together, and perhaps depressed at the angles, by the operation of the proper muscle, Now, in the cheerful expression, there is bviously a considerable amount of muscular energy put orth; a number of comparatively powerful muscles have been rompted to contract through their entire range. Here we have confirmation of the general principle. It might seem hard o say, why nature selected those muscles for more especial timulation when the bodily powers responds to a thrill of leasure. These preferences are obviously a part of our con-titution. So far the case accords with our view. But turn ow to the painful expression, and what do we find? An pparently mixed effect.* On the one hand, there is a relaxa-on of those parts that were made tense under a pleasurable ave, which is what we should expect. If this were all, the roof would be complete; the state of pain would be accom-anied with loss of muscular energy in the features of the face. ut this is not all. It would appear that new muscles are rought into play, for example, the corrugator of the eyebrows, e orbicular of the mouth, and the depressor of the angle of e mouth. Thus, if energy has been withdrawn from one class, nother class have been concurrently stimulated. It is not en loss, but *transference*, of power that we witness. It was om looking at the matter in this light, that Müller declared e selection of some muscles to be acted on under pleasure, d others under pain, as inexplicable; and Sir C. Bell spoke the depressor of the angle of the mouth as a specific muscle the expression of pain. A closer investigation, however, ill show that even this putting forth of energy under pain, hich appears so inconsistent with the general principle above unciated, is really in keeping with that principle. It is the

Induction
+ Exception

* 'In sorrow, a general languor pervades the whole countenance. The olence and tension of grief, the lamentations and the tumult, like all strong citements, gradually exhaust the frame. Sadness and regret, with depres-on of spirits and fond recollections, succeed; and lassitude of the whole dy, with dejection of the face and heaviness of the eyes, are the most striking aracteristics. The lips are relaxed, and the lower jaw drops; the upper elid falls and half covers the pupil of the eye. The eye is frequently filled th tears, and the eyebrows take an inclination similar to that which the pressors of the angles of the lips give to the mouth.'—*Anatomy of Expression,* 151.

play of certain muscles of *small calibre*, whose contraction makes the relaxation of the larger muscles more complete. By a very slight putting forth of power, we can impart such a *pose* to the active organs generally, as enables them more thoroughly to renounce all stimulation, to disengage vital energy for behoof of the other parts. Thus, by a slight exercise of the flexor muscles of the body and the limbs, we can carry the relaxation of the extensors (the really energetic muscles) much farther than would happen by suspending their own proper stimulus. So in the face. A certain slight exertion of the corrugator of the eyebrows, perfects the relaxation of the more powerful muscle that elevates the eyebrows; the concurrence of a small stream of energy in the orbicular of the mouth, and the depression of the angle, assists the zygomatic and buccinators in relaxing themselves to the full. By the employment of a small force, we may be supposed to release a still greater quantity; so that, after all, the positive exertion of those muscles that operate under pain, merely co-operates in the general direction of the discharge or renunciation of energy on the whole. I venture to say, that but for this effect, they would not be stimulated at all in depressing emotions; were it not that the outlay is more than repaid by a saving, they would continue unmoved in those circumstances. Why is it that a forced sadness of the countenance makes the heart bitter,—that the employment of a certain amount of muscular energy serves to compose the body and the limbs to rest after fatigue? Simply that the *general mass* of muscle may attain the *maximum* of relaxation; a result gained only by the contraction of some portions. The body being moved at all points between opposing forces, we cannot relax every muscle of the body at once; the utmost we can do is to relax those that have born the burden and heat of the day, and are the greatest in mass and energy; which necessitates the contraction of such as are opposed to them. I hold, therefore, that the tension of some members under pain does not invalidate, but rather confirms, the principle in question.

Another exception is the energetic expression prompted by acute pains. No one can say in the case of a man starting from a violent scald, that there is a relaxation of muscular energy; there is most manifestly the contrary. This seems a flat contradiction to our doctrine. In truth, however, this is the operation of another law of the constitution submerging at the moment the main principle, but only to make it emerge in still stronger relief. Sudden and acute pain is a stimulant of the motor nerves of the system. These become all alive for the instant, and throw a violent current into the moving members, inspiring a temporary spasmodic energy. Nothing could be more emphatically opposed to the doctrine here maintained than the appearance thus presented. But look at the other side of the picture. In the first place, this spasmodic burst has drawn away the regular supply of nerve force from the organic functions; all which will be found to be seriously impaired on the occasion; so that, at best, there is but a disturbance of the usually healthy direction of the vital power. And, in the next place, consider what happens at the end; how frightful the prostration that follows this painful stimulation. We shall then be convinced that, on the whole, power has been profusely sacrificed, although from the susceptibility of the nerves to an acute stimulus, there was for a time a manifestation of unusual energy.*

22. The consideration of the two great convulsive outbursts, Laughter and Sobbing, belongs to this part of the subject.

I shall say nothing at present as to the cause of Laughter: enough that it is a joyful expression. The principal in the case is the Diaphragm, all else is subordinate and secondary.

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* 'In pain, the body is exerted to violent tension, and all the emotions and passions allied to pain, or having their origin and foundation in painful sensations, have this general distinction of character, that there is an energetic action or tremor, the effect of universal and great excitement. It must at the same time be remembered, that all the passions of this class, some more immediately, others more indirectly, produce in the second stage exhaustion, debility, and loss of tone, from over-exertion.'—*Anatomy af Expression*, p. 154.

That large muscle, which is ordinarily engaged in contracting the chest so as to expel the air from the lungs, being the chief agent in expiration, is convulsed in laughter; in other words, it is made to undergo a series of rapid and violent contractions. Some great accession of stimulus from the brain has reached it, and the consequence is that the person 'draws a full breath, and throws it out in interrupted, short, and audible cachinnations.' A charge of nervous power has been generated somewhere, and is here discharged into the great muscle of expiration. The concurring or subsidiary actions also indicate an increase of power. When the laughter is audible, we know that the vocal chords have been made tense through a stimulus applied to the muscles of the larynx. The features also participate, and put on the smiling attitude at its fullest stretch. Whether, therefore, we look at the principal, or at the accessory, movements in laughter, they alike imply that new power has been evolved somewhere; and it is next to be seen, whether this is a real addition to the general vitality, or merely a transference from one part to another, impoverishing some organs while violently stimulating others, as we have seen to be the case in the convulsions of pain. Now, except in excessive and immoderate laughter, or unusual depression of the system, it cannot be said that any vital function is starved, through the amount of force discharged in this violent manifestation. The testimony of mankind is in favour of the genial operation of laughter; but if digestion, perspiration, the exhalation from the lungs, or the action of the heart, were weakened to supply those convulsive movements of the diaphragm, we may be quite sure that the reaction would be unequivocally depressing, no less than that of acute pains. The proof is decisive that this outburst of joyful emotion is a sudden heightening of the powers of life, which more especially shows itself in increased and convulsive expiration, in vocal tension, and in the pleased expression of the features.

The convulsive outburst of *grief* contrasts strikingly with the above. The principal in the effect is still the convulsive action of the chest; but mark the difference. The expiration, which in the other was violently increased, is *rendered slow.* The diaphragm must answer for this fact, or rather the nervous centres that maintain it in operation. These centres, instead of overflowing, have become bankrupt; they cannot even keep up the usual supply of power. This partial stoppage, or paralysis, of the diaphragm is a key to the whole phenomenon. To prevent suffocation, the muscles of inspiration have to be stimulated by efforts, like the application of bellows to inflate the lungs of a drowning man; this forces on by reaction an additional expiratory impulse. The great declension of vital energy is apparent. The accessories attest the same fact. The voice is feebly exerted, and the consequence is a long-drawn, melancholy note. The pharynx is convulsed, and is incapable of its rhythmical movements in swallowing. The features are relaxed, except in so far as they sympathise with the efforts of forced inspiration. These appearances are sometimes modified, as when a robust child bursts out in a violent fit of crying, expending a great deal of energy on the occasion. Great animal spirits can afford this manifestation; and it may be little else than an outlet for surplus power, having less of sorrow than of anger. But that would not be the fair or typical instance. In all cases, the reaction shows that power has been wasted and the system impoverished, the very opposite of laughter.

The lachrymal effusion is an accompaniment of grief, but there are also tears of joy. In the extreme of merriment, the eye is moistened and suffused. We can easily suppose, that an increased vital stimulus of the lachrymal gland and sac would promote the secretion of the healthy liquid, and that this, by coursing over the sensitive surface of the eyelids, would give a certain genial sensation, which we enjoy in the happy moods of tender emotion. The amount may be increased so as almost to reach the point of visible drops, and still be of the genial character. But we must not presume that the profuse stream that overflows in the outburst of grief, is merely the same action carried one stage farther. The common fact of abundance of liquid does not prove that all else is the same. As we may have a profuse salivation, containing very little of the material that avails for insalivating the food, so we may have a profuse lachrymal effusion, caused, not by the increased but, by the diminished action of the gland, in which case the quality would be radically changed. I make this assumption partly on speculative grounds, and partly because I think any one will recognise a difference in the sensation of the eye-lids, when moistened under a joyful wave, and when the moistening comes of pain or depression.

Not only in painful states, but also in extreme instances of pleasurable emotion, the blood vessels of the brain are congested, and the effusion of tears is one mode of relief.

23. The principle now contended for not only explains a large and important region of facts, but is essential to the preservation of the individual. If pleasure were something subversive of vital force, our system would be a house divided against itself. On the other hand, if the above principle were rigorously true, we should never be inwardly moved to act in a manner prejudicial to our physical welfare. That we are so moved is a proof of the existence of some modifying influence, and this we must endeavour to ascertain in order to complete the theory of pleasure and pain. We have seen that the ordinary pleasures of the five senses do not point to any great or marked increase of vitality; and we might say the same of many of the special emotions—wonder, affection, power, knowledge, fine art, &c. That these are accompanied by some increase of vital power is proved by their expression, which is of a lively animated kind, whenever the pleasure is considerable. But it could not be said, that the increase of vigour in the system at large corresponds on all occasions to the degree of the pleasure. A still more startling exception is presented by the Narcotic stimulants, for these are known to debilitate and waste the powers of life. And if it be maintained that this is only an after consequence, and corresponds to the stage when the mental tone has changed to pain and depression, I reply that such is not strictly the fact; a man drinking to intoxication loses his physical energy before

the feeling of exhilaration abates; and the pleasurable excitement of tobacco and opium may continue under an almost total prostration of the vital forces.

We are thus called upon to qualify the doctrine that connects Pleasure and Self-conservation, by another doctrine connecting Pleasure with Stimulation. The precise limits of this second principle are to be determined by an examination of the facts.

24. It is convenient to divide the modes of stimulation into two classes: First, what may be called the natural stimulants of the Senses and the Emotions; and secondly, Narcotics and Drugs.

First. On examining the natural stimulants of the Senses, what we appear to find is this. Touches, Sounds, Sights, are all pleasurable within certain limits of *intensity*. Pain in three higher senses arises from excess in the stimulus applied. The point of excess is exceedingly variable in different persons, and in the same person at different times; and notoriously depends upon the vigour of the system. So that we may say with certainty, as regards the sensations of Touch, Hearing, and Light, that sensation, as such, is pleasurable within limits determined by the strength of the nervous system. As regards the chemical senses, Taste and Smell, we cannot lay down the rule in the same positive manner; we cannot affirm the difference between painful tastes or odours and those that are pleasant to be merely a difference of acuteness. We do not at present understand what are the distinctive modes of action of sweet and bitter tastes on the nervous substance, and we may not say, regarding tastes and odours, that sensation as such is pleasurable. It may be that a bitter taste is a too violent agitation of the nerves, like a painfully sharp sound, or smart, but we have no grounds but the analogy for making the assertion. At all events, these pleasures and pains are not obviously explained in the principle of Conservation: both the one and the other are referable purely to the principle of Stimulation. A bad odour does not owe its painful agency to depression of vitality, nor a sweet odour to the opposite fact. They both require us to assume that certain modes of exciting the nerves, irrespective of the rise of physical vigour, general or local, are accompanied with pleasure, and certain other modes with pain.

Some of the simpler emotions can be easily explained on one or other of the two principles. Wonder is a pleasurable stimulant, if not applied out of proportion to the vigour of the system. So with tender feeling, with the sentiment of power, fine art, &c. Many of the painful emotions are associated with depressing agencies: fear, sorrow, shame, are familiar examples. These may also operate as perverse stimulants, or irritants, of the nervous system.

And now, in the second place, as regards narcotic stimulation, we have a series of substances—alcohol, tobacco, tea, opium, haschish (Indian hemp) betel-nut—that are pleasurable, but hardly in any degree favouring vital action. We may allow them some influence in promoting the physical vigour for a brief interval of time, but their effect, as stimulants of the mental tone, is out of all proportion to the most that can be claimed for them in that respect. On the other hand, if carried beyond certain narrow bounds, they undermine and destroy the human constitution; and the principle of self-conservation is not always able to avert that consequence. The only possible way of rendering an account of this phenomenon, is to recognise certain modes of operating upon the substance of the nerves, as concomitants of a pleasurable mental excitement.

25. We might, not without plausibility, maintain the position that Stimulation is the sole cause of pleasure, and that the nourishment of vital energy merely enables this to be pushed to greater lengths, without degenerating into pain. The facts would undoubtedly bear this interpretation. It could be said that stimulation of some kind can never be absent; and that by increasing the vital power, this stimulation falling on the refreshed nervous substance, would impart the pleasurable tone. But it is better, in the present state of our knowledge, not to push either principle to exclusive pre-

dominance. A certain physical vitality, in some organs at least, if not an essential condition of a pleasurable tone, can always enhance the effect of the other causes, and in practice is often all that we need to look to.

The contrast of country and city life familiarly illustrates the two principles. The pleasure of the one results mainly from the conservative and healthy or vitalizing influences, the pleasure of the other from variety of stimulation. It is possible to attain a measure of happiness by either mode. High health is not an essential of pleasure; the nerves may respond to agreeable stimulations in the midst of some (not all) modes of bodily weakness. The readiness to take on the thrill of intense pleasure is a *speciality* of the nervous constitution; the state of the general system, and more particularly of the glandular organs, is an important element in the case, but the main foundation is to be sought in an endowment of the nerve tissue. A man may have, as it were, a natural genius for being happy. (For a notice of the various opinions on the physical accompaniments of Feeling, see Appendix.)

OF THE INSTINCTIVE GERM OF VOLITION.

26. In a former chapter, I endeavoured to establish, as an important fact of the human system, that our various organs are liable to be moved by a stimulus proceeding from the nervous centres, in the absence of any impressions from without, or any antecedent state of feeling whatsoever. This fact of spontaneous activity, I look upon as an essential prelude to voluntary power, making indeed one of the terms or elements of Volition; in other words, Volition is a compound, made up of this and something else.

Neither the existence of spontaneous actions, nor the essential connexion of these with voluntary actions, has been, so far as I am aware, advanced as a doctrine by any writer on the human mind; but the following interesting extracts from Professor Müller will show that he has been forcibly impressed with both the one and the other of these views.

'It is evident that the ultimate source of voluntary motion cannot depend on any conscious conception of its object; for voluntary (I should say 'spontaneous,') motions are performed by the fœtus before any object can occur to the mind, before an idea can possibly be conceived of what the voluntary motion effects; we must therefore view the question in a much simpler manner. On what do the first voluntary movements in the fœtus depend? All the complex conditions which give rise to voluntary motions, in the adult, are here absent. Its own body is the sole world from which the obscure conceptions of the fœtus that excite its actions can be derived. The fœtus moves its limbs at first, not for the attainment of any object, but solely *because it can move them.* Since, however, on this supposition, there can be no particular reason for the movement of any one part, and the fœtus would have equal cause to move all its muscles at the same time, there must be something which determines this or that voluntary motion to be performed,—which incites the retraction, first of this foot or arm, and then of the other.'—Müller, p. 935.

This last supposition, as to the equal tendency of all the muscles to come into action through the spontaneous activity of the centres, is, I think too absolutely stated. There can hardly exist such a perfectly balanced charge of the centres, as to make all of them equally ready to commence a stimulus of the muscles under their control, like the ass of Buridan between the two bundles of hay. It will always happen that some one will be more prone to act than another, from the mere state of constitutional or nutritive vigour belonging to it: and when that one has exhausted itself, the discharge of some other may be expected. Then, as to the tendency to move first one foot and then the other, we have already seen that this alternation is provided for by a distinct arrangement referable, in all probability, to the cerebellum; so that when by any means a motion of the legs is commenced, that motion is guided in an alternating cycle. I continue the quotation from Müller.

'The knowledge of the changes of position, which are produced by given movements, is gained gradually, and only by means of the movements themselves; the first play of the will on single groups of the radicle motor fibres of the nerves in the medulla oblongata, must therefore be independent of any aim towards change of position; it is a mere play of volition, without any conception of the effects thereby produced in the limbs. This voluntary [say rather spontaneous] excitation of the origins of the nervous fibres, without objects in view, gives rise to motions, changes of posture, and consequent sensations. *Thus a connexion is established in the yet void mind between certain sensations and certain motions.* When subsequently a sensation is excited from without, in any one part of the body, the mind will be already aware that the voluntary motion, which is in consequence executed, will manifest itself in the limb which was the seat of sensation; the fœtus in utero will move the limb that is pressed upon, and not all the limbs simultaneously. The voluntary movements of animals must be developed in the same manner. The bird which begins to sing, is necessitated by an instinct to incite the nerves of its laryngeal muscles to action; tones are thus produced. By the repetition of this blind exertion of volition, the bird at length learns to connect the kind of cause with the character of the effect produced.

'We have already learned from many other facts, that the nervous principle in the medulla oblongata is in a state of extraordinary tension, or proneness to action; that the slightest change in its condition excites a discharge of nervous influence, as manifested in laughing, sneezing, sobbing, &c. While the tension of the nervous principle is not disturbed, we are equally ready to excite voluntary movements in any part of the body, and such is the state of rest or inaction. Every mental impulse to motion disturbs the balance of this tension, and causes a discharge of nervous influence in a determinate direction,—that is, excites to action a certain number of the fibres of the nervous motor apparatus.'—p. 936-7.

This last view I conceive to be an accurate statement of the nature of nervous energy. The nervous system may be compared to an organ with bellows constantly charged, and ready to be let off in any direction, according to the particular keys that are touched. The stimulus of our sensations and feelings, instead of supplying the inward power, merely determines the manner and place of the discharge. The centres of speech and song, for example, when fresh and healthy, may either overflow so as to commence action in a purely spontaneous way, or they remain undischarged till irritated by some external influence, as, for example, the sound of another voice. The bird whose morning song has lain dormant for a time, breaks forth at the stimulus of another songster just begun.

27. We must now, therefore, specifically consider what there is in volition over and beyond the spontaneous discharge of active impulses upon our various moving organs,—limbs, body, voice, tongue, eyes, &c. If we look at this kind of impulse closely, we shall see wherein its defect or insufficiency lies, namely, in the random nature of it. Being dependent on the condition of the various nervous centres, the discharge is regulated by physical circumstances, and not by the ends, purposes, or uses of the animal. When the centres of locomotion are fresh and exuberant, as in the dog unchained of a morning, the animal sets off at the top of his speed; the force once exhausted, the creature comes to a stand-still in the same spontaneous way, like a watch run down. But this moment of exhausted energy is the very moment when an animal ought properly to be active in procuring food and replenishment to the system; and there ought to be in the state of exhaustion itself a stimulus to act, just as a watch run down would require, in order to be self-sustaining, to touch some chord that would set a-going a power to wind it up, or as a dying fire ought to act on a spring for putting on fresh coals. Mere spontaneity, therefore, stops far short of what our volition does for us in the way of self-preservation; a power that dies out when action is most needed, cannot be the appropriate support of our existence.

Müller's application of the term 'voluntary' to the initial movements prompted solely by the state of tension of the nerve centres is not strictly correct; these movements are but one term of the couple that makes up an act of volition; both a feeling and a movement are necessary parts of every such act. A morsel of food on the tongue sets a-going the movements of mastication; this is a voluntary effort, an effort prompted and controlled by a feeling, namely, the sensation of taste or relish. Acts performed without any stimulus of feeling are usually described as involuntary; such are the spasms of disease and the reflex movements already noticed.

There is, in the mature animal, a power in certain feelings or emotions to originate movements of the various active organs. A connexion exists between our emotional states and our active states, sufficient to constitute a link of cause and effect between the one and the other. The question is whether this link is original or acquired.

Dr. Reid has no hesitation in classing the voluntary command of our organs, that is, the sequence of feeling and action implied in all acts of will, among instincts. (See his chapter on Instincts, *Essays on the Active Powers*.) The power of lifting a morsel of food to the mouth is, according to him, an instinctive or pre-established conjunction of the wish and the deed; that is to say, the emotional state of hunger coupled with the sight of a piece of bread, is associated, through a primitive link of the mental constitution, with the several movements of the hand, arm, and mouth, concerned in the act of eating.

This assertion of Dr. Reid's may be simply met by appealing to the facts. It is not true that human beings possess at birth any voluntary command of their limbs whatsoever. A babe of two months old cannot use its hands in obedience to its desires. The infant can grasp nothing, hold nothing, can scarcely fix its eyes on anything. Dr. Reid might just as easly assert that the movements of a ballet-dancer are instinctive, or that we are born with an already established link of causation in our minds between the wish to paint a landscape and the movements of a painter's arm. If the more perfect command of our voluntary movements implied in every act be an acquisition, so is the less perfect command of these movements that grows upon a child during the first year of life. At the moment of birth, voluntary action is all but a nonentity.

28. According to this view, then, there must be a process of *acquirement*, in the establishing of those links uniting feeling with action, which volition implies. But the acquisition must itself repose upon some primordial fact, or instinct, of our nature. The point is to ascertain what connexion there is, at the outset of life, between our feelings and our movements, which the course of our experience and education converts into mature volitions.

I will endeavour to indicate what seems to me the precise situation wherein a feeling prompts an action in the beginning.

Although in the completely-formed will, a state of pleasure can induce the actions necessary for prolonging it,—as when a crowd follows a military band,—in the infancy of the being, pleasure can induce action of some kind, but not necessarily of the right kind. There is no relevance in the heightened movements of the child under pleasure, no proper direction given to them for sustaining or increasing that pleasure, as would happen at a later period. Still, there is an effect of quickened energy when an agreeable feeling suddenly takes possession of the mind. We have seen that an increase of vital power is a concomitant of pleasure, (this holds even under the principle of Stimulation); which increase passes sometimes to the organic functions alone, and sometimes to the active functions or the muscles, and not unfrequently to all parts, especially in the freshness of early life. Now the important result as regards the will, is the *muscular* accession. If the system is previously quiescent, there will be a burst of energy ; if already acting, the action will be increased. Still there will be no determination in one course rather than in another ; there will be no preference, and therefore no proper volition.

But suppose now that the movements arising out of mere physical exuberance, should be accidentally such as to increase the pleasurable feeling of the moment; the very fact of such increased pleasure would imply the other fact of increased energy of the system, and of those very movements then at work. The pleasure would in this way feed itself, and we should have something amounting substantially to a volition. Spontaneity, or accident, has brought certain movements into play; the effect of those movements is to induce a burst of new pleasure: but we cannot induce pleasure without inducing new energy to the physical system, and therefore to the members acting at the moment. So long as these movements add to the pleasure, so long they add to their own stimulation. Let them cease to yield new accessions of delight, and there will be an end to their farther acceleration as the result of increased vital energy.

29. Before producing actual instances, let us complete the general statement by supposing the opposite condition, that of pain. Let movements be commenced as before, through the spontaneous energy of the healthy system, but let those movements occasion a sudden feeling of pain. In doing so, they occasion also, in virtue of the connexion above contended for, an abatement of the vital energies, which abatement, extending to the movements, brings them more or less to a stand-still. (To avoid complicating the case at this stage, I must suppose that the pain is not an acute smart, which would irritate the nerves and induce the spasmodic movements of pain; that is no doubt a genuine natural agency, but as it is not of universal occurrence we can here assume that it does not take place. In following out the consequences of pain as such, the depression of the powers of life is the chief, and the only indispensable, effect). But this effect is exactly what is wanted in the present instance, namely, to check movements that are the cause of suffering; and the end is as much answered through the agency in question, as it is afterwards when the will attains its full development. If a cessation of active energy is the remedy for a state of

suffering, that remedy lies in the fact itself, for suffering and abated force go together. The application of this fact is peculiarly apparent in the modes of dealing with men and animals. If we wish to repress too much activity in a living being, pain is the sure instrument. A slight pain, no doubt, may have the opposite effect, for reasons that we have seen; but a severe pain will certainly succeed. The natural, the direct agency of pain is to abate vital power, muscular action included. The instantaneous consequence of even a slight hurt is often to stop activity for the instant. Thus, then, we see that when movement concurs with pain, the pain arrests the movement through its general depressing agency; while, on the other hand, a movement bringing pleasure is sustained and promoted through the connection between pleasure and exalted energy.

30. Take the example of sucking, a voluntary act which the infant, man or animal, must be capable of at the moment of birth. At the outset, there must be a reflex process, causing the embrace of the nipple to be followed by the movements of the tongue. The voluntary stage is attained, when the feeling of pleasure can operate to sustain the action once commenced. But how does this feeling possess the power to induce the continuance, perhaps to heighten the energy, of the act? I conceive it is the elevation of all the powers of life by the action of the nutritive material upon the stomach, including the moving members in actual operation, namely, the chest, tongue, and mouth. To put forth additional energy in masticating, swallowing, &c., when the food is agreeable to us, is a voluntary power at any time of our life. Let us now suppose that the point of satiety is reached, and that the child gives over of its own accord at that point. The meaning, then, plainly is, that the contact of the liquid with the full stomach is no longer stimulating to the powers of life, that in fact, if persisted in, the contrary result takes place. The wave of energy extending to the sucking parts now fades away, and they themselves fall into inaction; in other words, the infant ceases just as if it knew that it had enough; the

fact being that the painful state of mind called satiety, is accompanied with a lowered condition of the active organs, which ultimately arrests the movement that is causing the satiety ; *not, however, as in after life, by specially withdrawing power from that part, but by the round-about process of cutting off power at all points.* The primordial force of volition knows nothing of singling out one member from the rest ; this comes by a series of tentatives and early struggles. Pleasure can raise the energy everywhere, pain lower it everywhere ; the power of discriminative selection is not born with us, and must be acquired.

I have supposed the case of a pleasure concurring with a movement that feeds it ; and of pain concurring with a movement that occasions it ; and we have seen the natural results. A third case, of equal, if not greater, frequency in animal life, is the following :—A creature is in pain, or under a depressing condition of mind ; the direct consequence, or natural accompaniment, is a lowered state of the vital energies. Nevertheless random movements are still performed ; the spontaneity may not always be exhausted ; and perhaps the pain has produced that other effect of spasmodic irritation of the nerves. At all events movements occur ; the limbs are thrown about, the head is tossed from side to side, and so forth. Now, let the pain instantly cease. Mentally, the result is a great reaction, in fact a burst of pleasure ; physically, there concurs the usual elation of the system, moving members among the rest. The movements that were going on when the pain ceased, receive a sudden accession of power out of the general fund, and are made all the more energetic. Apply this to a particular instance. A new-born animal lies on the ground in an uneasy condition of mind. It knows nothing of the cause, and as little of the remedy. The physical accompaniment of the state is a languid condition of the bodily members, supposing no acute stimulation of the nerves. Still the moving energies are entirely subdued. The spontaneous tendencies, prompting now to one part now to another, make it at last spring to its legs and commence a forward locomotion. (These are results of mere spontaneity.) With the locomotion the uneasiness sensibly subsides. Say that the animal is thereby withdrawn from too great proximity to the fire. Now every felt abatement of the uneasy sensation is a throb of pleasure, and carries with it the usual physical stimulation. The inevitable consequence is, that the locomotive movement accidentally begun shares in the heightened energy imparted to the system, concurrently with the relief from the pain, and is consequently quickened. If the relief still goes on, so does the stimulation, until the uneasy state has passed away even from the remembrance; at which stage no further increase takes place, and the animal, after giving full vent to the energy thus imparted, falls away again to the resting posture. If, however, in avoiding Scylla, the creature were to come upon Charyldis, the course would be reversed; a new pain encountered would have its effect in arresting action; a pain increasing at every step would accelerate the downward career of depression, until movement were no longer possible.

To take another example. An infant lying in bed has the painful sensation of chillness. This feeling has its usual depressing accompaniments, and may or may not cause the convulsive outburst of pain, what we may term the characteristic *emotional* expression. At all events spontaneous movements occur, whether from natural healthy power or from irritated nerves. In the course of these spontaneous movements there occurs an action bringing the child into contact with the nurse lying beside it; instantly warmth is felt, there is a throb of pleasure, and a concurrent stimulus to the physical system. The successful movement is sustained, and made more energetic, and the contact is kept up. Such would be the natural operation of the law that connects pleasurable relief with increased energy. The child twelve months old can perform this act by a true selective volition: the child of three days can do it only at random, and by the help of the principle we have been explaining. A process of acquirement has, I believe, occurred in the meantime, which is exemplified in the present volume (CONTIGUITY, *Associations of Volition*), and at still greater length in the Emotions and the Will (WILL, Chap. II.)

31. There are various actions, commonly called Instincts, that are only phases or results of this fundamental property of mind. *Self-preservation*, implying the revulsion from pain and injury, and the appropriation of the means of subsistence, is an example of volition as now explained. We have as a rule no original tendency to protect ourselves from injurious influences, if they do not affect us as pains, nor to lay hold of beneficial influences that give no present pleasure.

Certain special instances of early precaution against harm are often remarked upon, as a portion of the original provision of nature in our behalf. Thus *the dread of falling* is very strong in early life, and stimulates powerful efforts by way of prevention. But this is no other than an instance of volition in general. The remembrance of the acute pain of a past fall is one source of the spur to preserve the stability of one's footing. And even still earlier, and before experienced hurts can operate as a warning, there is a severe and distressing sensation in the sudden loss of support. that prompts us vigorously to act for restoring the firm position. The case is distinguished only by the remarkable virulence of the pained condition, and the corresponding degree of volitional stimulus manifested under it.

OF THE SPECIAL ACTIVITIES AND INSTINCTS.

Under this head would fall to be considered Locomotion, the Voice, Mastication, and the Constructive and Destructive apparatus, &c. Locomotion is an interesting subject in itself, but for the purposes of the present treatise I do not consider the full exposition of it at all necessary. The notice already taken of the subject in the earlier part of this chapter must suffice.

32. So deeply does the power of Speech enter into the operations of Mind—Feeling, Action, and Intelligence—that the mechanism of the organ deserves a full description.

Of the Voice.

I shall first make a few quotations from the Anatomy of the Voice.

'The upper part of the air passage (from the lungs) is modified in its structure to form the *organ of voice.* This organ, named the larynx, is placed at the upper and fore part of the neck, where it forms a considerable prominence in the middle line. It lies between the large vessels of the neck, and below the tongue and hyoid bone, to which bone it is suspended.'

'The larynx is cylindrical at the lower part, where it joins the trachea (or windpipe), but it widens above, becomes flattened behind and at the sides, and presents a blunted vertical ridge in front.

'The larynx consists of a framework of cartilages, articulated together and connected by proper ligaments, two of which, named the *true vocal cords,* are immediately concerned in the production of the voice. It also possesses muscles, which move the cartilages one upon another, a mucous membrane lining its internal surface, numerous mucous glands, and lastly, blood-vessels, lymphatics, and nerves, besides cellular tissue and fat.'

Cartilages of the Larynx.—'The cartilages of the larynx consist of three single and symmetrical pieces, named respectively the *thyroid cartilage,* the *cricoid cartilage,* and the *cartilage of the epiglottis,* and of six others, which occur in pairs, namely, the two *arytenoid cartilages,* the cornicula laryngis, and the cuneiform cartilages. Of these, only the thyroid and cricoid cartilages are seen on the front and sides of the larynx (see fig. p. 314); the arytenoid cartilages, surmounted by the cornicula of the larynx, together with the back of the cricoid cartilage, on which they rest, form the posterior wall of the larynx, whilst the epiglottis is situated in front, and the cuneiform cartilages on each side of the upper opening.'—QUAIN, vol, iii, p, 288.

Confining ourselves as much as possible to the parts immediately connected with voice, I require to call attention principally to the thyroid and cricoid cartilages, the two arytenoid cartilages, the true vocal cords, and the muscles that move the cartilages and thereby affect the tension and position of the vocal cords.

'The *thyroid* (shield-shaped) cartilage (see fig. 10) is the largest of the pieces composing the larynx. It is formed by two flat lamellæ united in front at an acute angle along the middle line, where they form a vertical projection which becomes gradually effaced as it is traced from above downwards. The two lamellæ, diverging one from the other backwards, embrace the cricoid cartilage, and terminate posteriorly by two thick projecting vertical borders, separated widely from each other; hence the thyroid cartilage is altogether wanting behind. The angular projection on the anterior surface in the median line is subcutaneous, and is much more prominent in the male than in the female, being named in the former the *pomum Adami.*'

'The *cricoid* cartilage, so named from its being shaped like a ring, is thicker in substance and stronger than the thyroid cartilage; it forms the inferior, and a considerable portion of the back part of the larynx, and is the only one of the cartilages which completely surrounds this organ. It is deeper behind, where the thyroid cartilage is deficient, measuring in the male about an inch from above downwards, but is much narrower in front, where its vertical measurement is only two lines and a half. The cricoid cartilage is circular *below*, but *higher* up it is somewhat compressed laterally, so that the passage through it is elliptical, its antero-posterior diameter being longer than the transverse.'

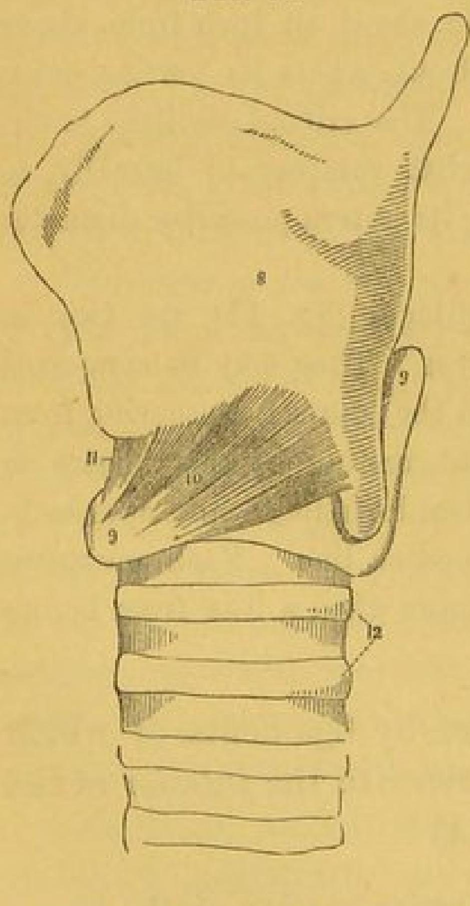
'The *arytenoid* (ewer-shaped) cartilages (fig. 11) are two in number, are perfectly symmetrical in form. They may be compared to two three-sided pyramids recurved at the summit, measuring from five to six lines (half an inch) in height, resting by their bases on the posterior and highest part of the cricoid cartilage, and approaching near to one another towards the median line. Each measures upwards of three lines in width, and more than a line from before backwards.'—Vol. iii. p. 288--91.

The cartilages are bound together by ligaments, of which I omit the description. The appearance of the *interior* of the larynx is given as follows (see fig. 11):

'On looking down through the superior opening of the larynx (where it communicates with the pharynx above and is bounded by the epiglottis, &c.), the air passage below this part is seen to become gradually contracted, especially in its transverse diameter, so as to assume the form of a long narrow fissure running from before backwards. This narrow part of the larynx is called the *glottis*. Below it, at the upper border of the cricoid cartilage, the interior of the larynx assumes an elliptical form, and lower down still it becomes circular. The glottis is bounded laterally by four strongly marked folds of the mucous membrane, stretched from before backwards, two on each side, and named the *vocal cords*. The *superior* vocal cords are much thinner and weaker than the inferior, and are arched or semi-lunar in form; the *inferior* or *true* vocal cords are thick, strong, and straight. Between the right and left inferior vocal cord is the narrow opening of the glottis, named the *rima glottidis*, and sometimes the *glottis vera* or *true glottis*.'—Vol. iii. p. 295—6.

The inferior or true *vocal cords*, by whose vibration the voice is produced, are two bands of elastic substance, attached in front to about the middle of the depression between the wings of the thyroid cartilage, and behind to the arytenoid cartilages; from this connexion they are called thyro-arytenoid ligaments. They consist of closely arranged parallel fibres of that peculiar tissue occurring in some other parts of the body, named the *yellow elastic tissue*, being probably the most perfectly elastic substance of a ligamentous kind that nature has produced. India-rubber is employed, as an extremely inferior imitation, in making artificial instruments resembling the larynx. The upper and free edges of the cords, which are sharp and straight, are the parts thrown into vibration during the production of the voice.

Fig. 10.*



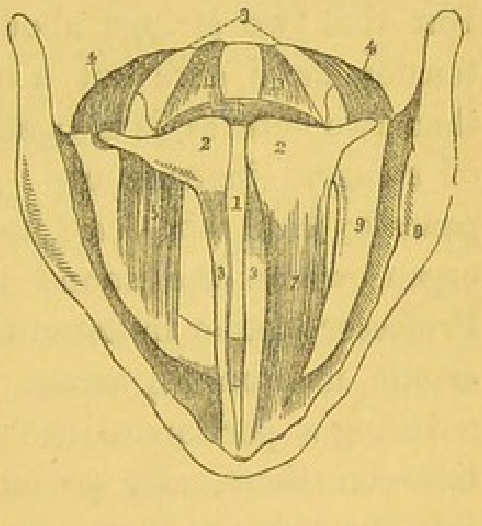
33. With reference to the *muscles* of the larynx, I may

* 'Side view of the thyroid and cricoid cartilages, with part of the trachea; after Willis.—8. Thyroid cartilage. 9. 9. Cricoid cartilage. 10. Crico-thyroid muscle. 11. Crico-thyroid membrane, or ligament. 12. Upper rings of the trachea.'—(Quain, vol. iii. p. 229.)

state beforehand that the principal movements to be effected by them relate to the change of tightness and the change of distance of the two cords, for which purposes opposing pairs are necessary. By one action the cords are tightened, by another relaxed; by a separate action they are approximated, and by the antagonist of this they are parted asunder.

The great muscle of tension of the cords, the foremost and most powerful of all the muscles of the voice, is the *crico-thyroid* exhibited in the figure. 'It is a short, thick triangular muscle, seen on the front of the larynx, situated on the fore part and side of the cricoid cartilage. It *arises* by a broad origin from the cricoid cartilage, reaching from the median line backwards upon the lateral surface, and its fibres, passing obliquely upwards and outwards, and diverging slightly, are *inserted* into the lower border of the thyroid cartilage.' The contraction of the two crico-thyroid muscles causes the thyroid and cricoid cartilages to turn on each other behind; thus if we suppose the cricoid cartilage to remain fixed, the upper part of the thyroid is carried forward or away from the other, drawing with it the ends of the vocal cords, which are attached behind to the cricoid cartilages through the arytenoid (see fig. 11). In this way the vocal cords are stretched in proportion as the muscle contracts itself. The counteracting or antagonistic muscles are exhibited in the fig. (No. 7)

FIG. 11.*



* 'A diagram, slightly altered from Willis, showing a bird's-eye view of the interior of the larynx.—1. Opening of the glottis. 2. 2. Arytenoid cartilages. 3. 3. Vocal cords. 4. 4. Posterior crico-arytenoid muscles. 5. Right lateral crico-arytenoid muscle; that of the left side is removed. 6. Arytenoid muscle. 7. Thyro-arytenoid muscle of the left side; that of the right side is removed. 8. Upper border of the thyroid cartilage. 9. 9. Upper border and back of the cricoid cartilage. 13. Posterior crico-arytenoid ligament.'—(QUAIN, vol. iii. p. 301).

passing between each arytenoid cartilage and the thyroid near the extremity of the vocal cords.

In governing the aperture of the glottis, we find a muscle passing between the two arytenoid cartilages (6), and therefore by its contraction drawing them together, and thus approximating the cords. The cords are separated, and the glottis widened, by a pair of muscles, exhibited in the figure (4, 4), passing between the arytenoid and cricoid cartilages behind. No. 5 in the figure is another muscle connecting the same two cartilages laterally, and operating to contract the glottis.

34. *The Larynx, considered as an instrument for the production of sound.*—It has long been a question what kind of instrument the larynx should be compared to, in order to illustrate the manner of its action in giving out sound. From the existence of two vibrating strings or cords, the first and obvious supposition was to rank it with stringed instruments, such as the violin, where the same string produces a higher or lower note according to the degree of tightness given to it. But that two strings, about an inch long, should so vary in tension as to give out a range of notes, extending to more than two octaves, is altogether unparalleled in the experience of stringed instruments. A more accurate comparison appears to hold with *reed instruments*, such as the pipe of an organ, where the sound is produced by a vibrating reed. Professor Müller imitated the human voice by stretching two elastic membranes across the mouth of a short tube, each covering a portion of the opening, and having a chink left between them. By prolonging the membranes downward into the tube, so that not merely their edges, but their whole planes, might be thrown into vibration, Mr. Willis carried the imitation of the human Glottis still farther. By experimenting on an artificial glottis thus formed, it appeared that various notes could be obtained by altering the tightness of the tongues: the more tense they are, the higher is the note produced. ‘It is true that a scale of notes, equal in extent to that of the human voice, cannot be obtained from edges of

leather; but this scale is much greater in india-rubber than in leather; and the elasticity of them both is so much inferior to that of the vocal ligaments, that we may readily infer that the greater scale of the latter is due to its greater elastic powers.' It is also found that in membranous tongues the increased strength of the blast can somewhat raise the pitch, the tension remaining the same.

I quote the following summary of the action of the voice, from a paper in the Proceedings of the Royal Society (June 19, 1862), by Mr. John Bishop, containing the results of actual inspection of the movements of the vocal cords, with the aid of the *Laryngoscope* of Professor Czermak :—

'In ordinary breathing the glottis is wide open, and the arytenoid cartilages are thrown wide apart; but on the production of the most simple sound, these cartilages are suddenly and rapidly closed, and the edges of the vocal cords come into juxtaposition with each other, so as to leave no interval between them in their entire length.

'In the production of the lower tones of the voice, the vocal cords may be seen to vibrate throughout their whole length, and even at their prolongations at the base of the arytenoid cartilages; they seem to vibrate also throughout their entire breadth. As the pitch of the tones rises in the scale, the length of the cords in a state of vibration diminishes, and they are pressed more closely against each other: as the tones become more acute, the pressure is increased, and the tension of the vocal cords augmented; the breadth of the cords is also diminished.

'When the chest tones have arrived at the limit of the scale of acute range, and the falsetto tones commence, the glottis is seen to be more closely pressed together, and the edges only of the vocal cords are suffered to vibrate, as Garcia has already observed. On the other hand, while the chest tones are produced, a larger surface of the vocal cords is in a state of vibration. When the falsetto tones are produced, it appears that the very extreme edge only of the cord vibrates, and a much less expenditure of breath is required. While the highest notes of the voice are intoned, the vocal cords are so closely pressed together, that a small portion only of the glottis is seen to yield to the pressure, which takes place nearly at its central portion.

'From the inspection of the vocal organs now so easily obtained, it may be stated in general terms that, as the voice ascends from its lowest to its more acute tones, the lengths of the vibrating portions of the vocal cords are proportionally diminished, while at the same time their tensions are increased: and, in fact, they present the same phenomena as those of musical chords, and they appear to obey the same laws, as Ferrein so long since supposed, and which have since been confirmed by Müller and by myself.

'Moreover, the vocal cords form a kind of valve, which is situated in a tube, and acts on the column of air in the manner of a reed.

'It is observed that while the pitch of the tones of the voice becomes more grave, the epiglottis is depressed and the pharynx is relaxed; and, on the contrary, as the pitch becomes more acute, the epiglottis is raised and the pharynx becomes contracted: the depression of the epiglottis probably assists in deepening the pitch of the vocal tube in the same manner as the lid of an organ pipe does.

'In the production and modulation of the voice, it is astonishing with what accuracy some persons are able to produce at will, sounds of a determinate pitch and of a quality which charm and captivate the ear of a musician. The muscles which are principally concerned in this faculty are the thyro-arytenoid and the lateral crico-arytenoid. The crico-thyroid is limited to stretching the vocal ligaments.

'The mere turning of the vocal cords on their axes, out of the vocalizing position, does not afford sufficient space for ordinary breathing, as supposed by Mr. Willis, but we find that the arytenoid cartileges and vocal cords are widely separated during ordinary breathing.

'With regard to the controversy as to whether the vocal organs are to be considered as a stringed instrument or as a reeded pipe, it has been thought by some physiologists that the same organs cannot possibly perform the offices of both. However, under the denomination of reeded pipes, we find a great variety of form and structure, and it is not difficult to conceive that while the time of an oscillation of the vocal ligaments obeys the same laws as musical strings, the valve of the glottis in opening and closing the vocal tube performs an action resembling that of some of the musical reeds.

'The human organs of voice have been considered by a great many distinguished philosophers as constituting a reeded instrument, and the relation in which they stand to instruments of that character has been already discussed in my paper in the 'Transactions' of the Royal Society for the year 1846; it only remains to remark that the phenomena brought to light by means of the larngoscope tend to confirm the idea that the vocal organs really perform the double effect both of reed and string.

'In ejaculatory sounds, such as the production of the syllables há, há, há in laughing, the glottis is opened at each intermission and closed at each intonation of sound, thus producing a rapid succession of opening and closing the glottis.'

The difference between the male and female voice lies in the size of the larynx and length of the vocal cords; both which are greatest in the male. Within the same sex there are gradations in these particulars.

35. The musical voice depends on the action of the vocal cords, in conjunction with the other parts of the larynx; the cranium also operating as a resounding mass. The *articulate* voice involves, in addition, the action of the mouth, tongue, and nostrils. Articulation may involve the musical voice, or the action of the cords; it may, also, be toneless. In a whisper there is no musical sound. We may exert the voice to a considerable degree of loudness, without introducing tones, in which case, it may be supposed that the windpipe is made vocal by its rings or other parts, and not by the usual medium of the cords. Such toneless speech involves a great expenditure of power, and the propulsion of a great volume of air, and is, for that reason, as well as on other grounds, avoided.

The articulate sounds are commonly divided into vowels and consonants, but the division is not founded on any broad line of demarcation. Certain letters have come to be called vowels, and others to be called consonants.

The following experiment illustrates the nature of *vowel* formation :—

'Open the mouth to its greatest possible extent—with the lips naturally drawn back, so that the edges of the teeth are visible—and emit an utterance of voice; it will sound, *ah!* Continue sounding this vowel while you *cover the mouth* firmly with the hand, laying the fingers of the left hand on the right cheek, and slowly bringing the whole hand across the mouth; the vowel quality of the sound will be changed with every diminution of the vocal aperture, progressively becoming *uh, aw, oh, oo,* as the hand gradually covers the mouth.'*

The changes of the mouth for different vowels are chiefly two, expressed by the terms *buccal* and *oral,* the one referring to the size of the cavity of the mouth, the other to the opening of the lips. The modifications of these, coupled with the position of the tongue, give rise to all the varieties of vowel sound. An estimate has been made of the comparative dimensions of the two openings in the principal vowels. Admitting five degrees of size, both of the opening of the mouth and of the space between the tongue and palate, Dr. Carpenter, slightly altering from Kempelen, states the dimensions of these parts for the different vowels as follows :—

Vowel.	*Sound.*	*Size of oral opening.*	*Size of buccal cavity.*
a	as in *ah*	5	5
a	as in *name*	4	2
e	as in *theme*	3	1
o	as in *cold*	2	4
oo	as in *cool*	1	5

Of the *consonants* a great many divisions have been made. A certain play of the tongue, teeth, or lips is necessary in all of them. This play may vary from the mere quiver of the tongue in sounding *s,* to the forcible shutting off of the sound by the sudden closure of the lips in *p* final. The sounds *p, t,* and *k,* are connected either with sudden closures or with explosive openings of the vocal current, and are called *mutes* and also *explosive* letters. Of these three, *p* being formed by the lips, is called a *labial ; t* being formed by the contact of the tongue with the palate, is a *palatal* and also a *dental ;* and *k* is a *guttural* or throat-formed letter, the contact of the tongue being much farther back in the palate As all the consonants are formed more or less nearly in one or other of these three positions, a general division of them can be made into labials, palatals, and gutturals. Six distinct

* Bell's *Elocutionary Manual,* p. 21.

Labials are enumerated, depending on different ways of sounding with the lip closure. The mute or explosive *p* has been mentioned; next to it is *b*, produced by a less violent closure, which allows the voice to be heard during the act, as any one will feel by sounding *cup* and *cub*. The third labial is *m*. This is a nose sound; the friction of the air on the nasal cavities gives the humming character; and the closure of the lips distinguishes it from the other nose sounds; it is therefore the *nasal* labial, while *b* is called the *vocal* labial. The fourth labial is *f*, produced by the upper teeth and the lower lip coming together, and the breath passing through them without voice; this is the whispered or *aspirate* labial. When voice is heard through this last closure, we have *v*, or the second vocal labial, called the *vocal aspirate*. Lastly, a sound may be emitted through the closed lips, making them vibrate or shake like a reed, as in the sound *prr*: this is the *vibrating* labial, or the labial *r*. A similar series can be described in the Palatals. The mute being *t*, the vocal is *d*; there are two forms of the nasal, *n* and *l*; the aspirates are *th* (*th*umb), *s*, *sh*, arising from slightly differing positions of the tongue in its contact with the palate; the vocals, or audible forms of these, are *th* (*th*y), *z*, *j*: the vibratory palatal is the common *r*. The Gutturals likewise show the same list of varieties. First *k* the mute; then the vocal *g*; the nasal *ng*, a simple sound, though spelt in our language with two letters; the aspirate *ch* (Scotch and German) as in *loch*, together with its fainter form *h*; the vocal aspirate *gh* unknown, and almost unpronounceable by us; and the vibratory *ghr*, occurring as a burr in some people's utterance. This classification, for which we are indebted to Dr Arnott, may be summed up in the following table:—

	Labials.	*Palatals.*	*Gutturals.*
Mute	*p*	*t*	*k*
Vocal	*b*	*d*	*g*
Nasal	*m*	*n*, *l*	*n*, *g*
Aspirate	*f*	*th*, *s*, *sh*	*ch*, *h*
Vocal Aspirate . .	*v*	*th*, *z*, *j*	*gh*
Vibratory . . .	*prr*	*r*	*ghr*

36. *Mental Phenomena of Voice.*—The voice, being a moving or active organ, presents all the mental facts and phenomena belonging to the moving organs in general. Exercise gives birth in it to a mass of feeling of the muscular kind, pleasurable when within due limits, with sense of fatigue and need of repose.

The tension of the vocal organs is always accompanied with an action of the chest, and this action needs to be stronger than an ordinary expiration. When the cords are made vocal without any reinforcement of the chest, we have a groan, or a wail, according as the tension is small or great, the one being a deep tone and the other acute. But such is the association between high notes and increased exertion of the lungs, that it is difficult to produce a wail with only the ordinary breathing force.

In appreciating the pleasure springing out of vocal exercise, or the sensibility of the larynx under exertion, we must allow for this action of the respiratory organs, and also for the sensation of the resulting sounds on the ear. There can be little doubt, however, that when both these are deducted from the effect, there still remains a very considerable source of pleasure due solely to the play of the laryngeal muscles, and which renders the free employment of the voice an important item of bodily gratification.

37. Besides the feelings of pleasure or of pain diffused from the vocal apparatus, there is ,as in all the other muscles, a distinctive sense of the degree of tension of each separate muscle, such as to indicate the varying positions of the tube and the vocal cords. We have one feeling for the absence of tension, another for a low degree, a third for a higher degree and so on. The sound produced at each of those stages, comes to be associated with the corresponding muscular condition of the organ, and hence we get the power of imitating sounds or of producing them at pleasure. The association between the sound in the ear and the vocal position and movement producing it, enables the one to recall or reinstate the other.

THE INTELLECT.

WE now proceed to view the Intellect, or the thinking portion of the mind. The various faculties known as Memory, Judgment, Abstraction, Reason, Imagination,—are modes or varieties of Intellect. Although we can hardly ever be said to exert this portion of our mental system in separation from the other elements of mind, namely, Feeling and Volition, yet scientific method requires it to be described apart.

The primary, or fundamental attributes of Thought, or Intelligence, have been already stated to be, Consciousness of *Difference*, Consciousness of *Agreement*, and *Retentiveness*. The exposition of the Intellect will consist in tracing out the workings of these several attributes.

(1). The first and most fundamental property is the Consciousness of Difference, or Discrimination. To be distinctively affected by two or more successive impressions is the most general fact of consciousness. We are never conscious at all without experiencing transition or change. When the mental outburst attending such change is characterized mainly by pleasure or pain, we are said to be under a state of Feeling. If the prominent fact is the sense of difference, or the discrimination of the two opposite modes, or if the sense of agreement of the present impression with some former impression is the chief mental occupation, we are properly considered to be intellectually engaged. There are many transitions that give little or no feeling in the sense of pleasure or pain, and that are attended to *as* transitions, in other words, as differences. In states of enjoyment or suffering, we are not devoid of the consciousness of difference; but we abstain from the exercise of the discriminating and identifying functions, and follow out the consequences of a state of feeling as such, the chief of these being to husband the pleasure and abate the pain, by voluntary actions.

In the foregoing detail of the Feelings of Movement and the Sensations, the properties of each, as regards Feeling, and as regards Intellect, have been separately considered. In some of the Senses, as the Organic Sensibility, Feeling is nearly every thing. In Taste and Smell, both feeling and discrimination are fully manifested. In Touch, and still more in Hearing, and in Sight, there are states of pleasure and of pain, and also a great number of sensations that are indifferent in those respects, and whose character it is to call forth the sensibilities to difference and to agreement. These last are the proper Intellectual Sensations, and they have always been described as such. Thus the degrees of roughness or smoothness, of hardness or softness in Touch, are nothing as feeling, and everything as knowledge. Heat may be in such amount as to give intense pleasure or pain; it may also be wanting in either respect, and may occupy the mind purely with the sense of degree. The sensations of sound, in the same way, may incline to Feeling, as in the pleasure of Music, or to Intellect as in articulation. Light, colours, and visible forms have, similarly, a double aspect.

The sense of Difference, or Discrimination, has therefore been unavoidably illustrated, almost to exhaustion, in the enumeration of the muscular feelings and the sensations. As a power of mental Reproduction, or a means of bringing back former states of mind—which is a principal application of our Intellectual function—the property of discrimination shows itself in one form, called the associating principle of Contrast. As identical with the law of the Relativity of all feeling and knowledge, it must emerge at a great many points, and be everywhere tacitly implied.

Some notice will have to be taken of acquired discrimination, but this is one of the applications of the Retentive power of the mind.

The conscious state arising from agreement in the midst of difference is the natural complement of the foregoing attribute; the two together exhaust the primitive forms of intellectual susceptibility. But in the order of exposition, we shall give precedence to the property of Retentiveness, inasmuch as the following out of Agreement in its higher applications must presuppose the whole range of our acquired knowledge.

(2.) The fundamental property of Intelligence, named Retentiveness, has two aspects, or degrees.

First. The persistence or continuance of mental impressions, after the withdrawal of the external agent. When the ear is struck by a sonorous wave, there is a sensation of sound, but the mental excitement does not die away because the sound stops; there is a certain continuing effect, generally much feebler, but varying greatly according to circumstances, and on some occasions quite equal to the effect of the actual sensation. In consequence of this property, our mental excitement, due to external causes, may greatly outlast the causes themselves; we are enabled to live a life in ideas, in addition to the life in actualities.

But this is not all. We have, secondly, the power of recovering, or reviving, under the form of ideas, past or extinct sensations* and feeling of all kinds, without the originals, and by mental agencies alone.

After the impression of a sound has ceased entirely, and the mind has been occupied with other things, there is a possibility of recovering from temporary oblivion, the idea, or

* Although we can hardly avoid using such terms as 'recover,' 'revive,' 'reproduce,' 'recollect,' with reference to Sensations, it is to be borne in mind that there is a radical difference between the Sensation and the recollection of the Sensation, or what is properly termed the Idea. This fundamental and unerasable difference relates to the sense of objective reality which belongs to the sensation, and not to the idea. The sensation caused by the sight of the sun is one thing, and the idea or recollection of the sun is another thing; for although the two resemble each other, they yet differ in this vital particular. For many purposes, the idea can stand in the room of the sensation; the recollection of things often answers the same ends as the real presence. But there is one great question connected with our science, in which this distinction is the turning point of the problem, namely the question as to our perception and belief of an external world. In discussing that subject, we shall have to attend closely to the circumstances that characterise a sensation as distinct from the counterpart idea.

mental effect, without reproducing the actual sound. We remember, or bring back to mind, sights, and sounds, and thoughts, that have not been experienced for months or years. This implies a still higher mode of retentiveness than the previous fact; it supposes that something has been engrained in the mental structure; that an effect has been produced of a kind that succeeding impressions have not been able to blot out. Now one medium of the restoration to consciousness of a particular past state, is the actual presence of some impression that had often occurred in company with that state. Thus we are reminded of a *name*—as ship, star, tree—by seeing the thing; the previous concurrence of name and thing has led to a mental companionship between the two. Impressions that have sufficiently often accompanied one another in the mind seem as it were to grow together, so that they become at last, as it were, inseparable; we cannot have one without a disposition or prompting to renew all the rest. This is the highest form of the Retentive, or plastic, property of the mind. It will be exemplified at length under the title of Association by Contiguity.

3. The remaining property of Intellect is consciousness of Agreement. Besides the consciousness of difference, the mind is also affected by agreement rising out of difference. The continuance of the same impression produces no effect, but after experiencing a certain impression and passing away from it to something else, the recurrence of the first causes a certain shock or start, which we are all familiar with, the shock of recognition; and which is all the greater according as the circumstances of the present and of the past occurrence are different. Change produces one effect, the effect called discrimination; Similarity in the midst of change produces a new and distinct effect; and these are the two modes of intellectual stimulation. When we see in the child the features of the man, we are struck by agreement in the midst of difference.

The power of recognition, identification, or discovery of likeness in unlikeness, is another means of bringing to mind past ideas; and is spoken of as the Associating, or Reproductive principle of Similarity. We are as often reminded of things by their resemblance to something present, as by their previous proximity to what is now in the view. Contiguity and Similarity express two great principles or forces of mental reproduction; they are totally distinct powers of the mind, varying in degree among individuals, the one sometimes preponderating and sometimes the other. The first governs Acquisition, the second Invention.

The commonly recognised intellectual faculties, in so far as they do not involve Feeling or Volition, are resolvable into these three primitive properties of Intellect—Discrimination, Retention, Similarity. The faculty called Memory is almost exclusively founded in the retentive power, although sometimes aided by Similarity. The processes of Reason and Abstraction involve Similarity chiefly; there being in both the identification of resembling things. What is termed Judgment may consist in Discrimination on the one hand, or in the Sense of Agreement on the other: we determine two or more things either to differ or to agree. It is impossible to find any case of judging that does not, in the last resort, mean one or other of these two essential activities of the intellect. In passing along a succession of ideas joined by contiguous associations, the mind may be comparatively little excited, in fact we may be almost unconscious, if it is a train often repeated:* but a new difference, or a newly-discovered agreement,

* 'Mr. Stewart has made an ingenious attempt to explain sundry of the phænomena referred to the occult principle of habit, in his chapter on Attention, in the first volume of his *Elements of the Philosophy of the Human Mind.* It is to be regretted that he had not studied (he even treats it as inconceivable) the Leibnitzian doctrine of what has not been well denominated, *obscure perceptions, or ideas*—that is, acts and affections of mind, which, manifesting their existence in their effects, are themselves out of consciousness, or *apperception.* The fact of such latent mental modifications is now established beyond all rational doubt; and on the supposition of their reality, we are able to solve various psychological phænomena otherwise inexplicable. Among these are many of those attributed to Habit.'—Sir W. HAMILTON *Edition of Reid* p. 551.

awakens us like a surprise; we note the circumstance, which becomes ever after a fact known to us, a part of our intellectual stock. Lastly, Imagination is a product of all the three fundamentals of our intelligence, with the addition of an element of Emotion.

The exposition of Intellect proper will consist mainly in a full development of the two processes of Retentiveness and Agreement. These will constitute the two first chapters. A third chapter will be devoted to the cases of complicated mental reproduction, including the association by contrast. A fourth will deal with the applications of the intellectual forces in forming original constructions, giving rise to what is termed the Creative or Inventive faculty of the mind.

I shall close these introductory remarks with a brief indication of the purposes to be served by a scientific discussion of our intellectual powers. These are as follows:—

1. The explanation of the laws that regulate the stream and succession of our thoughts is calculated to gratify our curiosity, or the natural desire of knowing the causes of things. Every person alive to the pleasures of knowledge is led, by this prompting, to enquire into the laws that simplify the great complications of the world. And there is no department where this desire is more likely to arise, than in the ever present workings of the mind itself.

2. The theory of the intellectual powers affords a means of representing and explaining the differences of intellectual character in human beings. Such differences must refer to one or other of the fundamental attributes of our intelligence, and be susceptible of classification accordingly.

3. The art of education must be grounded upon an accurate knowledge of the attribute of Retentiveness. We should endeavour to find out the circumstances that favour, and those that thwart, the process of mental acquisition.

What Locke termed the 'Conduct of the Understanding,' meaning the economical and effective employment of all our intellectual forces, includes education, and some things besides.

It implies the methods of directing and aiding us in the higher operations, as Reasoning and Invention. It is to be presumed that a knowledge of the tools that we work with, may occasionally assist us in using them to the best advantage.

4. There are certain questions of vital interest, whose solution is dependent on an investigation of our intellectual powers. One of these is the great metaphysical problem, as to the reality of an external world. It was to ascertain exactly what it is competent for man to know, that Locke applied himself to the enquiries that are the subject of his essay, the publication of which constituted an era in the science of the human mind.

CHAPTER I.

RETENTIVENESS—LAW OF CONTIGUITY.

1. THIS principle is the basis of Memory, Habit, and the Acquired Powers in general. Writers on Mental Science have described it under various names. Sir William Hamilton terms it the law of 'Redintegration,' regarding it as the principle whereby one part of a whole brings up the other parts, as when the first words of a quotation recall the remainder, or one house in a street suggests the succeeding ones. The associating links called Order in Time, Order in Place, and Cause and Effect are all included under it. We might also name it the law of Association proper, of Adhesion, Mental Adhesiveness, or Acquisition.

The following is a general statement of this mode of mental reproduction.

> Actions, Sensations, and States of Feeling, occurring together or in close succession, tend to grow together, or cohere, in such a way that, when any one of them is afterwards presented to the mind, the others are apt to be brought up in idea.

There are various circumstances or conditions that regulate and modify the operation of this principle, so as to render the adhesive growth more or less rapid and secure. These will be best brought out by degrees in the progress of the exposition. As a general rule, repetition is necessary in order to render coherent in the mind a train or aggregate of images, as, for example, the successive aspects of a public way, with a sufficient degree of force to make one suggest the others at an after period. The precise degree of repetition needed depends on a variety of causes, the quality of the individual mind being one.

MOVEMENTS.

2. I shall commence the detailed exposition of the Law of Contiguity with the case of Muscular Activity, including under this head all kinds of movements, attitudes, and efforts of resistance.

Through the intellectual property of adhesiveness or plasticity, as expressed by this principle of contiguous association, movements can be linked together in trains and made to succeed each other, with the same certainty and invariable sequence as we find in the instinctive successions of rhythmical action already discussed. The complicated evolutions of a dance come to flow of their own accord, no less than the movements on all fours of the newly dropped lamb.

We may begin with remarking the operation of the adhesive principle, upon the spontaneous and instinctive actions themselves. These actions are plainly confirmed and invigorated by repetition. Although many creatures can walk as soon as they are born, they walk much better after a little practice. Here, however, we cannot easily make allowance for the growth of the parts themselves, apart from the effect of exercise. The muscles of the limbs increase in size, and the nerve-centres that stimulate and organise the rhythmical movements, acquire more development through time alone. We are, therefore, not in a good position, in the case of the instincts, to trace and estimate the amount of adhesive growth due to the general property of retentiveness. But knowing, as we do, how the power operates in all the voluntary operations, we are entitled to presume that it works also in the various instinctive operations. By practice, that is, by repetition, the infant sucks with more ease and vigour. In learning to walk, exercise undoubtedly concurs with the primitive alternating tendency of the limbs. The muscles of the body are strengthened by the mere action of growth ; this growth is accelerated if they are regularly exercised within limits; and the very same is likely to be true of the nerves and nerve-centres that dictate the flow and alternation of muscular movements.

I have endeavoured to establish, as a fact, the spontaneous commencement of all the actions that we term voluntary. The limbs, the features, the eyes, the voice, the tongue, the jaw, the head, the trunk, &c., commence to move in consequence of an unprompted flow of stimulus from the nerve-centres; this flow will be sometimes to one set of members and sometimes to another, so that the organs may act separately and independently, under the influence thus imparted. Now such spontaneous movements are without doubt confirmed by repetition, and are thereby made to recur more readily in the future. Any movement struck out by central energy leaves as it were a track behind, and a less amount of nervous impulse will be required to set it on a second time. By a spontaneous stimulus the hands are closed; the act of closing determines a current or bent in that direction, and the next exertion is so much the easier. By one prompting, the arms are raised and lowered alternately; by another, they are moved forwards and backwards; in the course of a few repetitions, adhesiveness comes in aid of the inward stimulus, and the movements grow more frequent and more decided. Through the spontaneous action of the centres, the eyes are moved to and fro, and iteration gives facility to the exercise. So the voice is moved variously by an impulse from within, and each movement and note is made easier for the next occasion when the centres discharge their energy by that channel. The tongue is an organ with many movements, and all voluntary; these commence of their own accord, and are strengthened and, as it were, developed by repetition. The inclinations and sweep of the head, and of the trunk generally, are of the same class. The iteration of all these various movements does not make them voluntary movements in the proper sense of the expression; but it prepares them for becoming such by a future and distinct acquisition. It makes them recur more frequently and more readily, enhancing the spontaneous impulse of the centres. On some one occasion, the voice sounds a high note. As to the first stimulus of the vocal energy, we can say nothing farther than that, with all the active organs, there is associated a nervous battery for commencing their movements. After an interval, the same high note is hit upon by a like discharge from the proper centre. When several repetitions have occurred in this way, a facility is gained; either a less tension of the centre will originate the note, or it will be better sustained when it comes. On a different occasion, a stream of sound is stimulated at a low pitch, which, after a number of opportunities, comes to be a ready effort of the organ. Thus it is that a variety of detached movements are getting themselves prepared for subsequent use.

To persons that have not reflected on the very great difficulty and labour attending the growth of voluntary movements in infancy, this hypothesis of spontaneity so much dwelt upon, will seem uncalled for and unlikely. But I shall have to show at a later stage, how impossible it is to account for the origin of volitional acts without a supposition of this nature.

3. We pass next to the acquisition of trains and aggregates of movements as exemplified in mechanical operations generally. I assume the case of an individual already able to command the limbs, or other parts, as directed by another person, or by an example set for imitation; and postpone the consideration of the mode in which this voluntary power is itself acquired, as demanding a far more subtle line of investigation.

The simplest acquisition is the case where something is added to a movement already established. Take the case of walking, and suppose that we desire to communicate a peculiar set of the limb, for example, the turning out of the toes. A voluntary act, directed to the muscle that rotates the thigh outward, gives the requisite position to the foot; and the act is sustained while the walking movement goes on. By this means, there grows up in course of time an adhesion between the tension of the rotator muscles and the several movements of walking, and at last they coalesce in one complex whole, as if they had been united in the original mechanism of the system. So the power of performing the diagonal step in military exercises is acquired by combining, with the ordinary walking impulse, a lateral movement determined at first by an express volition. In learning to walk originally, certain movements of the trunk have to be fused with the forward movements of the limbs, with a view to preserve the balance.

The acquiring of articulate speech extensively involves the same agglutination. Every letter demands an adjustment of tongue, jaws, and lips, difficult at first, but at last so easy that we do not know that we are performing a complicated act.

Let us next take the case of an acquired succession of movements. The sequence of acts in eating is an example taken from our earliest acquirements. The lifting of the morsel by the spoon or fork, the carrying it to the mouth, the opening of the mouth at the right moment, the action of the jaws and tongue,—all exhibit a succession of regulated acts fixed into mechanical coherence and certainty, by the mere fact that they have been made to succeed each other a great number of times. The action of carrying the hand to the mouth is followed by the opening of the jaws, as surely as the two alternate acts concerned in breathing give birth to each other.

In most mechanical successions, the feeling of the effect produced at each stage is a link in the transition to the next. Thus in writing, the sight of the part last formed is the preamble to what comes next, as much so as the motion executed; in which case the sequence is not one of pure motions—one motion bringing on the next in the habitual order. But the mixture of sensations and motions in complex trains will form a separate head; I am desirous, at this stage, to select examples of movements linked together, without any other element being present. As, however, the guidance by the feeling is necessary in the course of *learning* any mechanical effort, the fixing of movements in a train independently of such guidance is the last stage, or highest perfection, of mechanical acquirement. Thus, when one is playing on a pianoforte, and attending to something else at the same time, the sequence must consist purely of movements; that is to say, each stroke is associated with another definite stroke or touch, through the whole succession of the piece. Yet, even in this case, it is difficult to say how much there is of a kind of latent sensation in the fingers and the ear, sufficient for the purposes of association, acting along with the association of pure movements.

A deaf person speaking must depend almost entirely on the associated sequence of movements; the only other assistance being the muscular feelings themselves, which always count for something. In saying over, to one's self, words committed by rote, the sequence of articulate motions is perfect. One word uttered brings on the next, independently of either hearing or the feeling of articulation. This is a proof of the very great aptitude for associated movement belonging to the vocal organs; for hardly any other part of the body, not even the hands, can acquire such perfection of unconscious dexterity. In knitting, there is probably the same sequence of movements, acquired after thousands of repetitions. The simpler figures of dancing can be gone through, with this mechanical and unconscious certainty, after a great amount of practice; but the docility of the lower limbs is far inferior to the hands, while I should be disposed to reckon these second to the voice.

The difficulty of forming a perfect association of mere movements, and the dependence of most of the mechanical trains upon the sense of the effect produced, are curiously illustrated in the cases of paralysed sensibility. Thus, there is an often quoted case of a woman, who could not hold a baby in her arms except by keeping her eyes fixed upon it. She had no sense of weight in her arms, and the sustained tension of the muscles was not sufficiently associated with the taking up of the child, by the muscular link alone. The sight of the eye was able to supply the want of arm sensibility, but both could not be dispensed with.

A more familiar example of the same fact is the signing of one's name, an operation which by repetition has been brought up to the highest pitch of automatic or mechanical sequence; and yet when we make our signature without seeing it, the execution is very faulty.

It is the linking together of movements, so perfectly as to make them succeed one another without consciousness, that brings the acquisitions into comparison with the instincts. Such actions are sometimes called secondary-automatic.

Although very few of the cases of mechanical acquirement in general can belong to the class we are now considering, there are important distinctions of human character, founded on the facility of acquiring trains of movement, so as to keep them up with the least possible help from the guiding sensations and ideas. The trains of action so acquired cost the smallest amount of mental fatigue in the performance; they may, moreover, go on while the mind is employed upon other things.

4. The class of actions thus associated are voluntary actions; they are stimulated from the cerebral centre, and it is within the cerebral hemispheres that the adhesion takes place. A stream of conscious nervous energy, no matter how stimulated, causes a muscular contraction, a second stream plays upon another muscle; and the fact that these currents flow together through the brain, is sufficient to make a partial fusion of the two, which in time becomes a total fusion, so that one cannot be commenced without the other commencing also. The current that directs the lifted arm to the mouth is part of a complex stream that opens the jaw; the current that gives the position of the fingers of a flute-player is associated with another that fixes the lips, and a third that compresses the chest with a measured force. In virtue of passing through the common centre of the nervous system together, the many

different coinciding streams become after due continuance an aggregated unity, broken up only by some more powerful alliance.

In the same manner, we may express what happens in a succession of acts. If the brain stimulates a given movement, such as the utterance of an articulate syllable, and if after that, a second syllable is pronounced, there is a continuity established between the two, a sort of highway made, and a bent given to pass from the one act to the other; in the course of time and repetition the connexion is fully knit, and the transition becomes mechanical or automatic. The acts must be mental or conscious acts, lying in the course of the common stream of mental activity: which stream is turned first upon the one, passes next to the other, thereby, as the effect shows, establishing a tendency towards the same direction ever afterwards.

It may be very fairly assumed that this is a process of growth, like the natural development of the nerves and the muscles themselves. This view is ably expressed by Dr. Carpenter, Mr. Herbert Spencer, and others. Whether the growth lies in forming new cells, or in modifying the internal conducting power of the nerve fibres and vesicles, we are unable to say; there is no reason why both effects should not take place. But the circumstances connected with the process of education strongly favour the above comparison. We find, for example, that new acquirements are easiest and most rapid during early life, the time of most vigorous growth of the body generally. We find also that rest and nutrition are as much needed for educating the organs as for keeping up the bodily health. There is, moreover, a bound fixed to the rate of acquirements, and no amount of practice can enable us to get over it. The plastic or hardening operation takes a certain interval of time, and, although the current be never so much sustained by keeping at a thing, the rate of acquisition is not increased in the same degree.

In successions of movement, the completed act of one movement is the links that sets on the next. But it is in vain, at the present point of our knowledge, to enquire minutely into the steps of this subtle sequence.

5. The conditions that regulate the pace of acquisition of aggregates and trains of movement have a high practical, as well as a theoretical, interest. Most of these conditions are common to all kinds of acquisitions. Those that relate to movement are the following:—

(1.) The Command already acquired over the organs. This throws us back upon previous acquisitions, and upon deep peculiarities of character, that need not at present be discussed. It is well known that some persons, in commencing manipulation, have a much better command of their movements than others; that is, they get more readily at a posture or movement pointed out to their imitation. Previous to the plastic fusion, must come the proper performance of the separate acts that have to be made coherent. It is necessary to sound each note well before singing an air.

(2.) There is a natural force of Adhesiveness, specific to each constitution, and distinguishing one individual from another. This property, like almost every other assignable property of human nature, is known to be very unequally distributed. We can estimate the primitive differences, only after allowing for all the differences in the other circumstances that do not depend upon character. In the case now before us—the acquisition of movements—the fact is apparent in the very unequal facility shown by boys in the same school, or recruits drilled together, in mastering their movements.

(3.) The chief condition is Repetition or Continuance. In proportion to the repetition is the rate of cohesion, regard being had to the necessity of reposing the organs. It is possible, by means of repetition, to make up for deficiencies in other respects. We term that constitution most adhesive by nature, that needs the fewest repetitions to become perfect.

(4.) The concentration of the mind is of great moment in acquisition. This is a variable thing in the same individual.

In the first place, it depends on the nervous vigour of the moment, as contrasted with feebleness, exhaustion, or lassitude.

The voluntary energy that sustains an action rises and falls with the condition of the body; hence the freshness of the morning and the early part of the day determines the best time for drill. So also good health is a condition of education in general.

But the concentration of nervous energy may be prevented, by the diversion of the mind into some other channel, or the expenditure of the inward power on other efforts. *Distraction* or pre-occupation effectually checks our progress in any attempt; the motions may be made, but the coherence is feeble. Thus a child may go through the repetition of its lessons, but while the mind is elswhere, there is no progress in fixing them. Intense pleasure or pain, or emotion of any kind, excited by causes foreign to the work in hand, use up the mental expenditure, with the currents of circulation and nutrition, that ought to go to the plastic process.

The nervous energy may be called forth by mere volition. The voluntary effort is easy, according as it is supported by powerful present motives. The best of all stimulants is a positive enjoyment of the work in hand. If the exercise is of such a kind as to give more pleasure than anything open to the person at the moment, the available force of the system is brought to bear without any abatement; and the adhesive operation is then strongly favoured. Next to the gaining of some pleasure, immediate or remote, is the warding off of some pain. The application of pain is the last resource with unwilling learners. This likewise succeeds in forcing attention, but with a deduction for the loss of vigour attendant on pain, present or prospective. When the penalty is such as to excite the agitation of fear, the concentration thereby caused is attended with still greater ultimate waste of energy.

It is one of the peculiarities of what is called the *nervous temperament*, or a nervous system naturally prone to vigorous exertion (just as some constitutions are strong in muscle, and others in digestion), to expend itself copiously in all its efforts, emotional, voluntary, or intellectual. This is necessarily favourable to acquisition, as to every other mental manifestation.

(5.) In mechanical acquirements, we must not omit bodily strength as a favouring circumstance. The power of continuing the exercise without fatigue, and the great determination of nutritive matter to the muscles, which is implied in a strong bodily frame, cannot but be favourable to the fixing of movements and the forming of habits. Hence strong men may be expected to acquire athletic and handicraft accomplishments more easily than others. But although I am disposed to put some stress upon this point, I must account the quality of the muscle of inferior importance, in comparison with the quality of the nervous framework.

(6.) This leads to the last condition proper to be noticed in connexion with acquired movements, namely, the spontaneous activity of the system. An abundance of the natural or spontaneous activity constitutes the active or energetic temperament, and promotes the acquisition of new movements. The proof of this affirmation depends chiefly on the observations made on active temperaments, from which I believe it will receive ample confirmation, allowing always for the other conditions above enumerated, some of them quite as important as the present. It is usually the men of natural and abounding activity that make good sportsmen, adroit mechanics, and able contenders in games of bodily skill. Nor is the coincidence at all unlikely in itself; the same nervous power that disposes the frame to spontaneous movement, is likely to aid the plastic operation that fixes movements in consecutive trains.

We have now before us the principle of growth that confers upon human beings mechanical art, and the aptitude for labour and for endurance. By it we can create new circles of power, make others fall into decay, and distribute the human forces anew, so as to adapt them more expressly for each man's necessities and position in life.

IDEAL FEELINGS OF MOVEMENT.

6. The continuance and revival of a *feeling* of movement,

without the movement itself, that is, an *ideal* feeling, affords a new and distinct case for the associating principle to work upon; a case, too, of great interest as introducing us into the sphere of Thought.

This transition from the external to the internal, from the Reality to the Idea,—the greatest leap that can be taken within the compass of our subject,—needs to be prefaced by a consideration of the question—what is the probable seat, or local embodiment, of a sensation, or a mechanical feeling, when persisting after the fact, or when revived without the reality? The discussion of this question will interrupt, for a few pages, our exemplification of the law of contiguous adhesiveness.

7. All the Muscular feelings can be sustained for some time, after the physical cause has ceased. All the Sensations of the senses can be sustained in like manner, some more and some less easily; and they can afterwards be revived as ideas by means of the associating forces. What, then, is the mode of existence of these feelings bereft of their outward support and first cause? In what particular form do they possess or occupy the mental and cerebral system? This question carries us as far as we are at present able to go into the cerebral process of intelligence. It admits of two different answers or assumptions, the one old and widely prevalent, the other new but better founded. The old notion supposes that the brain is a sort of receptacle of the impressions of sense, where they lie stored up in a chamber quite apart from the recipient apparatus, to be manifested again to the mind when occasion calls. But the modern theory of the brain already developed (see Introduction) suggests a totally different view. We have seen that the brain is only one part of the course of nervous action; that the completed circles take in the nerves and the extremities of the body; that nervous action consists of a current passing through these completed circles, or to and fro between the ganglia and the organs of sense and motion; and that, short of a completed course, no nervous action exists. The idea of a cerebral closet is quite incompatible with the real manner of the working of nerve. Seeing, then,

that a sensation, in the first instance, diffuses nerve-currents through the interior of the brain outwards to the organs of expression and movement, the persistence of that sensation after the outward exciting cause is withdrawn, can be but a continuance of the same diffusive currents, perhaps less intense, but not otherwise different. The shock remaining in the ear and in the brain, after the firing of artillery, must pass through the same circles, and operate in the same way, as during the actual sound. We have no reason for believing that, in the self-sustaining condition, the impression changes its seat, or passes into some new circles that have the special property of retaining it. Every part actuated *after* the shock must have been actuated *by* the shock, only more powerfully. With this single difference of intensity, the mode of existence of a sensation enduring after the fact is essentially the same as its mode of existence during the fact; the same organs are occupied, the same current action goes on. We see in the continuance of the attitude and expression, the identical outward appearances, and those appearances are produced by the course of power being still by the same routes. Moreover, the identity in the inward mode of consciousness implies that the manner of action within the brain is unaltered.

8. Now, if this be the case with impressions *persisting* when the cause has ceased, what view are we to adopt concerning impressions *reproduced* by mental causes alone, or without the aid of the original, as in ordinary recollection? What is the manner of occupation of the brain with a resuscitated feeling of resistance, a smell, or a sound? There is only one answer that seems admissible. *The renewed feeling occupies the very same parts, and in the same manner, as the original feeling, and no other parts, nor in any other manner that can be assigned.* I imagine that if our present knowledge of the brain had been present to the earliest speculators, this is the only hypothesis that would have occurred to them. For where should a past feeling be re-embodied if not in the same organs as the feeling when present? It is only in this way that its identity can be preserved; a feeling differently

embodied must to all intents and purposes be a different feeling, unless we suppose a duplicate brain on which everything past is to be transferred. But such duplication has no proof, and serves no end.

It is possible, however, to adduce facts that set in a still clearer light this re-occupation of the sentient circles with recovered impressions and feelings. Take first the recovery of feelings of energetic action, as when reviving the exploits and exertions of yesterday. It is a notorious circumstance that, if there be much excitement attending their recollection, it is with difficulty that we can prevent ourselves from getting up to repeat them. The rush of feeling has gone on the old tracks, and seizes the same muscles, and would go the length of actually stimulating them to a repetition. A child cannot describe anything that it was engaged in, without acting it out to the full length that the circumstances will permit. A dog dreaming sets his feet a-going, and sometimes barks. The suppression of the full stage of perfect resuscitation needs an express effect of volition, and we are often even incapable of the effort. If the recollection were carried on in a separate chamber of the brain, it would not press in this way upon the bodily organs engaged in the actual transaction. The fact can only be, that the train of feeling is re-instated on the same parts as first vibrated to the original stimulus, and that recollection is merely a repetition which does not usually go quite the same length; which stops short of actual execution. No better example could be furnished than the vocal recollections. When we recall the impression of a word or a sentence, if we do not speak it out, we feel the twitter of the organs just about to come to that point. The articulating parts,—the larynx, the tongue, the lips,—are all sensibly excited; a *suppressed articulation* is in fact the material of our recollection, the intellectual manifestation, the *idea* of speech. Some persons of weak or incontinent nerves can hardly think without muttering—they talk to themselves. The excitement of the parts may be very slight; it may not go the length of perceptibly affecting the muscles, but in the brain and communicating nerves it still passes the same rounds, in a greatly enfeebled degree. The purposes of intellect can be served, even after this extreme enfeeblement of the currents, but their nature and their seat have not changed. They have not abandoned the walks of living articulation because they no longer speak out fully; they have not taken refuge in new chambers of the mind. We feel at any moment how easy it is to convert the ideas into utterances; it is only like making a whisper audible,—the mere addition of mechanical power. The tendency of the idea of an action to produce the fact, shows that the idea is already the fact in a weaker form. Thinking is restrained speaking or acting. If the disposition to yawning exists, the idea, anywise brought up, will excite the action. The suppressive effort usually accompanying ideas of action, which renders them ideas and not movements, is too feeble in this case, and the idea is therefore a repetition to the full of the reality.

9. Although at present engaged in preparing the way for the association of muscular feelings, yet the doctrine in hand being general for all states of mind, I must add some parallel instances of Sensation. Müller has furnished several in point. He says, 'the mere idea of a nauseous taste can excite the sensation even to the production of vomiting. The quality of the sensation is the property of the sensitive nerve, which is here excited without any external agent. The mere sight of a person about to pass a sharp instrument over glass or porcelain is sufficient, as Darwin remarks, to excite the well-known sensation in the teeth. The mere thinking of objects capable when present of exciting shuddering, is sufficient to produce that sensation of the surface in irritable habits. The special properties of the higher senses, sight and hearing, are rarely thus excited in the waking state, but very frequently in sleep and dreams; for that the images of dreams are really seen (under opium, images are actually seen), and not merely present in the imagination, any one may satisfy himself in his own person, by accustoming himself regularly to open his eyes when waking after a dream. The images seen in the

dream are then sometimes still visible, and can be observed to disappear gradually. This was remarked by Spinoza, and I have convinced myself of it in my own person.'—p. 945. As another striking example we may adduce the fact that the sight of food determines the flow of saliva in a hungry animal. The physiologist obtains saliva for experimental purposes, by presenting a savoury morsel to the view of a dog.

These and other cases that might be adduced, clearly confirm what has been said, as to the return of the nervous currents exactly on their old tracks, in revived sensation. We see that when the revival is energetic, it goes the length of exciting even the surface of sense itself by a sort of back-movement. We might think of a blow in the hand, until the skin was actually irritated and inflamed. The attention very much directed to any part of the body, as the great toe, for instance, is apt to produce a distinct feeling in the part, which we account for only by supposing a revived nerve-current to flow there, making a sort of false sensation, an influence from within mimicking the influences from without in sensation proper.—(See the writings of Mr. Braid, of Manchester, on Hypnotism, &c.)

10. The emotions and passions distinct from, but often accompanying sensations, are likewise similarly manifested in the reality and in the idea. Anger takes exactly the same course in the system whether it be at a person present, or at some one remembered or imagined. Nobody ever supposes in this case that the ideal passion is in any way different from the actual, or has any other course or seat in the brain. So with affection, egotism, fear, or any other sentiment or passion. In like manner, the remembrance of being angry, or puffed up, or terrified, will be a resuscitation of the identical state, and will actuate the same part, although the centrifugal wave may not be strong enough to agitate the surface as strongly as the original did. The recollection of the intenser feelings is necessarily weaker than the reality; the recollection of some of the less agitating sensations and feelings may be quite equal

to the reality. We can better afford the expenditure necessary for reviving mild and gentle emotions.

11. The tendency of an idea of the mind to become the reality is one of the controlling forces of our constitution ; it is a distinct source of active impulses. Our chief active faculty is expressed by the Will, or Volition, whose nature it is to urge us *from* pain on *to* pleasure. But the disposition to pass from a mere recollection, imagination, or idea, to the action that it represents,—not merely to think an act, but to do it,—is also a determining principle of human conduct, and often sets itself in opposition to the regular action of the will, as above defined. For the most part, the tendency is kept in check ; in ordinary circumstances, indeed, it does not manifest itself with any great energy, so that we may omit it from our reckoning of a man's motives. There are, however, circumstances that bring it forward as a considerable, and even preponderating, influence in individual conduct. The extreme illustration is seen under the mesmeric sleep, which has this curious effect, among others, that the patient is open to the reception of ideas suggested by another person, while the senses and the mind are unsusceptible to the external situation generally, and are to that extent asleep or unconscious. The wakefulness to our actual environment at each moment is necessarily the foremost circumstance in regulating our actions ; the influence of our ideas is usually subordinated to the influence of present realities. In sleep, the mind is dead to reality, and more or less awake to the current of ideas ; and in somnambulism and mesmeric sleep, and to a less extent in ordinary dreams, we act our ideas out to the full, the usual restraining power being dormant.

In waking moments, the general rule is that ideas do not act themselves out, and their urgency to do so is so small as to be in complete subjection to the will, operating under its ordinary motives. But there are times, when an idea possesses the mind so forcibly as to act itself out in opposition to the will, and therefore in opposition to those interests that the will should side with—the deliverance from pain and the furtherance of pleasure. This forcible possession is commonly the consequence of great excitement accompanying an idea, or its taking a more than usual hold of the mind, whereby it does not pass away with the intellectual currents, but remains and predominates over every other thought that seeks for admittance.

12. The domination of an idea is best seen in the workings of Fear. When any object causes fright, the idea of that object is stamped on the mind with an interest corresponding to the degree of the fright, and cannot be shaken off. The actions of the individual are in conformity to this idea, and not to his proper volitions. A mother is in a state of panic regarding a supposed danger to her child; she is no longer capable of acting for the best; the one exaggerated idea governs her whole conduct. The force that moves her is not the will, but resides in the circles of the intellect, inflamed into undue excitement on one idea. The healthy and regular action of the will, aiming at the suppression of pain and the procuring of pleasure, would work for subduing the state of panic, so as to leave the mind in a cool and collected condition, able to estimate the danger at its exact amount and with reference to all other interests. But the passion of fear is too much for the will. The idea rules the situation like a despot.

The principle is also illustrated by the predominance of purely painful ideas, even although not causing fright. The mere fact that an idea is disagreeable would suggest to the will to banish it, and we often succeed in banishing the thought of an object that pains us; but it sometimes happens that the intensity of the pain is such as to stamp it on the mind, and we cannot help acting it out, even to our own discomfort. Disgusts often exercise this unbidden ascendancy.

The fascination of a precipice is a familar and pertinent example of the same tendency. The idea of a falling body is so intensely suggested, that an effort of volition is necessary to keep the spectator from acting it out in his own person.

It is often remarked that a painful recollection will haunt a person through life. This is an undue susceptibility to the influence of an idea, a morbid submission of the intellect to the will. Insanity is the culmination of this peculiarity. The insane are very generally the victims of a diseased impression. Occasionally this may give them pleasure, as when the idea takes the form of exorbitant vanity. Generally, however, the idea is morbid and gloomy, and still it controls the actions.

13. The only way that I am able to explain the great fact of our nature, denominated Sympathy, fellow-feeling, pity, compassion, disinterestedness, is by a reference to the tendency of an idea to act itself out. We are able to conceive the pains of other beings by our experience of the like, and when we do so conceive them, we feel urged to the same steps of alleviation as if the pains were our own. We become possessed with the mere idea of pain, there being no reality corresponding; but yet this idea will induce us to act as if it represented a reality of our own experience. To see another person hungry and cold is to take on the idea of those miseries, and we are induced by the power of the idea to relieve the pain that occasioned it. But for some such domination of an idea, I see nothing in the constitution of the human mind that would make us sympathise with other men's pleasures and pains. The ordinary action of the will is to gain our own pleasures and to remove our own pains. This is all that can, strictly speaking, interest us. Each organization is more or less formed to work for conserving itself; and it would seem, at first sight, an irrelevance to go beyond this. The mere operation of the will, in the sense that we have always understood it, is strictly within the limits of self-conservation. But the intellect, which can form ideas of the mental condition of other sensitive beings, urges us to make those ideas actualities, or to induce the conduct that they would suggest, if the pains or pleasures were personal to ourselves. This is sympathy and disinterested conduct, which is an undoubted fact of our nature, although unequally manifested in the characters of individuals.

14. Much of the ambition and the aspirations of human

beings belongs rather to the sphere of fixed ideas, than to the sphere of volition prompted by pleasures. It is true that the things that we aspire after, are calculated to give us pleasure, but very often we indulge in ideal aspirations that are utterly impracticable, and that, if we were masters of ourselves, we would utterly disregard and repress. Unfortunately, however, a certain notion, say of power, wealth, grandeur, has fixed itself in our mind and keeps a persistent hold there, perverting the regular operation of the will, which would lead us to renounce whatever is hopeless or not worth the cost. Such phrases as 'insane ambition,' a 'fixed idea,' 'an overwhelming fascination,' are used to designate this not unusual phenomenon.

Our regrets for what we have lost are generally out of proportion to the pleasure that the objects gave us. We may feel a sincere and a strong regret for the loss of some one related to us, who was an unmitigated burden and misery. The regard to our pleasures and pains solely would cause this to be felt as a relief and a gratification; but we cannot so banish our familiar idea even although painful; we cannot forget, merely because our happiness would be increased by forgetting. Thoughts persist by a law that is not subject to the will, and not only persist, but interfere with the course of our actions and the pursuit of our interests.*

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* Correctly speaking, two forces are at work in determining the influence of fixed ideas. One is the tendency of the idea of an action to become the action, on which the exposition in the text took its rise. This tendency is exemplified in its unmixed operation in such instances as the infection of particular crimes, and in the operation of sympathy generally.

The other principle is the tendency of an idea to persist in the mind, in consequence of its intensity, or the intensity of the feeling that accompanies it. The power of the will is baffled by great mental excitement under any circumstances. It may be for our interest to banish a particular idea, aud give a footing to other ideas, which our intellectual forces are quite competent to suggest, but when a feeling of any sort, whether pleasure or pain, or excitement that is neither, has allied itself with an idea, the forces of intellectual association and the force of the will are equally impotent to displace that idea. This is the way that fear operates to prevent a man from following out the regard to his own well-being.

15. The general doctrine now contended for as to the seat of revived impressions is not a barren speculation; if true, it bears important practical inferences. In expressing and describing thought and the thinking processes—an operation of great subtility essential to our subject—the doctrine is of great service; it helps us in some measure to localize these processes, and the language that might otherwise be deemed figurative becomes literal. The imagination of visible objects is a process of seeing; the musician's imagination is hearing; the phantasies of the cook and the gourmand tickle the palate.

The identity between actual and revived feelings shortens our labour by enabling us to transfer much of our knowledge of the one to the other. The properties that we find to hold of sensation in the actual, we may after a certain allowance ascribe to the ideal. Thus the qualities of the sense of sight in any one person, as, for example, its discriminating power, would belong likewise to his visual ideas. The senses are in this way a key to the intellect.

16. I return now to the Association of Feelings of Movement. It generally happens that if we can perform a movement actually, we can also perform it mentally. Thus we can go through in the mind the different steps of a dance; in other words, the feelings of the successive evolutions have been associated together, as well as the movements themselves. It must not be supposed, however, that the adhesion of actual movements and that of mental movements run exactly parallel, and that if the one is perfect, so is the other. We may sometimes see a mechanic able to go through the actual steps of a process, but unable to go through them in his mind; the proof being that in describing them to another party he often forgets a step, and only remembers it by doing the thing. In this case, the actions are more adhesive than the traces of them. I cannot at present produce any instance to show, on the other hand, that a series of actions can be repeated mentally and yet not bodily; for as the mental actions are performed in the same circles, it usually needs only a

volition, often the removal of a restraint merely, to bring them to the full length of actuating the muscles. But as there is a class of persons whose activity is chiefly mental, while others come to the actual in most of their trains, I can easily suppose instances to arise in the first-named class where the mental succession is perfect, while the bodily succession would fail if it came to a trial.

17. The principal field of examples of the association of pure feelings of muscular action, is the voice. Most other cases are so complicated with Sensation, that they do not answer our present purpose. But in speech, we have a series of actions fixed in trains by association, and which we can perform either actually or mentally at pleasure; the mental action being nothing else than a sort of whisper, or approach to a whisper, instead of the full-spoken utterance. The child can repeat its catechism in a suppressed voice, as well as aloud. We can even acquire language mentally, or without speaking it out at all; that is to say, we can bring about a mental adhesion by itself, or with the bodily action wanting. In language this happens continually: for in reading a book we do not speak the words vocally; the articulate adherence takes place within the purely mental circles. In like manner, children, learning their lessons in school, as they do not get them aloud, must acquire the verbal successions in the same way. In going over the spelling book, they have to articulate the letters of each word a number of times, and then the whole word; after a sufficient repetition, the train of articulations coheres, and the one brings on the next without fail, whether spoken inwardly or aloud.

As a general rule, it is best to rehearse verbal exercises aloud, if they are to be performed aloud, just as in the case of other mechanical operations. As the sense of hearing is brought in the trains are sooner fixed in this way than in the other. Besides, by coming to the actual execution, we set on a current that is both more energetic and larger in its sweep, inasmuch as it takes in the full operation of the muscles. In the early school acquirements, where everything has to be spoken out to the master, the audible repetition is the best; in after days, when we go over a great deal of language merely as thought, or the silent links of action, the speaking out is not called for; it would be an unnecessary waste of time and muscular exertion.*

18. The circumstances that favour the cohesion of mental trains of movement, are nearly the same as those already detailed for actual movements. A certain repetition is requisite; this is more or less, according as the other circumstances are favourable, namely, the natural adhesiveness of the system, the concentration of nervous energy, and the spontaneous activity. In mere mental acquirement, the condition of bodily strength is of course not an essential.

We may assume a common character in the active organs in the same individual; an activity of temperament that shows itself in every kind of exertion—in limbs, voice, eyes, and every part moved by muscle—or a sluggish feebleness extending alike over every kind of exercise. But this does not exclude specific differences of endowment in separate members, making the movements of one more adhesive and acquisitive than those of others. Thus we may have a special developement of the cohesiveness of the articulating members,—the voice, tongue, and mouth,—through some special quality in the centres that actuate these organs. But, to the best of my judgment, if we confine ourselves closely to the active members, there is more usually a common character of adhesiveness than any marked inequality; and I am disposed to trace the actual differences to other circumstances, and chiefly to differences in the particular senses concerned in the case. I know no reason why a good hand and a dexterous

* In the processes of meditation and thought we are constantly forming new combinations, and these we can permanently retain if we have dwelt upon them sufficiently long. A speaker meditating an address trusts to the adhesiveness of his verbal trains, although they have been all the while in the state of mere ideas, he not having spoken them aloud.

foot should not generally go together. What is special to the important case of speech will come out as we proceed.

SENSATIONS OF THE SAME SENSE.

19. The next class of associable elements to be considered is the Sensations; and I shall confine myself in the first instance to the adhesion of impressions of the same sense,—touches with touches, sounds with sounds, &c. There are various interesting operations that fall under this head; we embrace under it the early education of the several senses.

In the inferior senses, there is not much scope for exemplifying the process; the Organic Feelings do not form any striking associations among one another. We might note such cases as the expectation of a series of painful feelings from the occurrence of some one, as in an attack of illness; but there is no need for dwelling on instances of this description.

Even in Tastes, it is not common to have any important associations of one with another. One might easily suppose the formation of a train of tastes, such that any one would suggest the others, but I hardly know any set of circumstances where it occurs in a prominent way.

So with Smell. If it so happen that we frequently experience a succession of smells in one fixed order, an adhesion will be formed between the different impressions, and in consequence, when one is presented all the rest will be ready to arise in succession, without the actual experience. In passing frequently through a garden along the same track, we might come to acquire a succession of odours, and from any one anticipate the next before we actually reach it.

But we rarely exist in a train of recollections of either Taste or Smell. They are difficult to realize perfectly, and what we recover chiefly about them is the expression, and the sentiment of liking or aversion that they produced. By a great effort of mind, we may approach very near the recovery of a smell that we have been extremely familiar with, as for example the odour of coffee; and if we were more dependent on ideas of smell, we might perhaps succeed much better; nevertheless, it must be admitted, that the recoverability of these states by mere mental association is of a low order.

20. But this leads me to remark on the effect of repetition in making any single impression adherent—in giving us a firm hold of it, so as to make it endurable and recoverable. The single taste of sugar, by repetition, impresses the mind more and more, and by this circumstance becomes gradually easier to retain in idea. The smell of a rose, in like manner, after a thousand repetitions, comes much nearer to an independent ideal persistence, than after twenty repetitions. So it is with all the senses, high and low. Apart altogether from the association of two or more distinct sensations in a group or in a train, there is a fixing process going on with every individual sensation, rendering it more easy to retain when the original has passed away, and more vivid when by means of association it is afterwards reproduced in idea. This is one great part of the education of the senses. The simplest impression that can be made, of Taste, Smell, Touch, Hearing, Sight, needs repetition in order to endure of its own accord; even in the most persistent sense, Sight, the impressions on the infant mind that do not stir a strong feeling, will be apt to vanish as soon as the eye is turned some other way. This is no more than the plastic property confirming the echo, or continuing wave, of a sensation when the agent is withdrawn. We might devote a separate illustration to this primitive phase of our retentiveness, but I do not know of any important applications of it, where there is not also a process of association between a plurality of sensations. Yet it is proper to remark, that this hardening of the separate impressions of sense, by which they are prepared for existing in the idea, is going on all the time that these links of coherence are in course of formation.

21. We pass on to the more intellectual senses, Touch, Hearing, and Sight.

In Touch we have various classes of Sensations; the more purely emotional,—as soft contacts and pungent contacts,—

and those entering into intellectual perceptions,—as the feelings of roughness, weight, elasticity, size, &c. In all these, there is room for the associating principle to operate, but our present illustration will keep in view chiefly the second of the two classes, or that concerned in the development of the Intellect.

The sensation of any one surface, with all its asperities, is a complex thing; it is an aggregate of impressions made on the skin, and having a certain arrangement and intensity. The face of a brush yields a number of impressions all occurring together; these must take on a certain coherence, so that the sensation in its entireness may survive the actual contact They must preserve their coexistence, and return *en masse* at an after time. In comparing one surface with another, as in choosing a tooth brush, it is necessary only that a complex impression of one should survive a few seconds while the other is felt; in comparing one with some other long since worn out, the permanence behoves to be much greater. So with surfaces of cloth or wood, of stone or metal, judged of by their asperity; an associating process must fuse the multiplex impression before it can endure when the original is gone. Some surfaces are distinguished by an aggregate of asperity and temperature, as the cold touch of a stone or a lump of metal, in which case the feeling of cold must cohere along with the other parts of the tactual impression.

When muscular feelings and exertions are superadded to the impressions made on the skin, we obtain the more complex notions of touch,—those that combine feelings of size, shape, and situation, with texture or surface. Here an adhesion needs to take place between the tactile and mobile impressions. In order that a workman may recognise his tool by the hand alone, he must have had frequent experience of the complex feeling that characterizes its contact—the tactile impression of rough or smooth, cold or warm—with the muscular impression of weight, size, and shape, these two last qualities being determined by the muscular situation of the hand while grasping it. A sufficiency of repetition will so fuse all these together, that the tool can be identified the moment it is touched.

In plastic operations, or in dealing with soft viscid matters requiring a particular consistency, as dough, clay, mortar, &c., it is necessary to acquire firm impressions of different qualities and degrees of consistency, so as to know when the proper point has been exactly reached. This demands the cohesion of a complex sensation of touch ; that is, a certain skin feeling of clamminess and roughness, with the muscular feeling of resistance, will have to cohere into one fixed whole that shall never waver, vary, or be obscured, by the concurrence of other differing impressions. The repetition requisite for such practical discrimination as plastic operators require is usually very great, amounting to hundreds or thousands of contacts. Individuals seem to differ exceedingly in their facility of fixing standard contacts by adhesive association. This is a case where it is impossible to mistake differences of natural character. Some cannot, in a whole life, acquire the nicety that others possess after a few months' experience. The delicacy of the skin and of the muscular sensibility must combine in most cases of this kind ; but it cannot be easily seen which of the two preponderates. A delicate muscular sensibility will show itself in other combinations besides touch. Moreover, some of the feelings included under touch have scarcely anything to do with the skin, as, for example, weight, size, and shape ; great delicacy of discrimination in these has a purely muscular origin ; while in judging of the texture of a cloth or the smoothness of a piece of mahogany, the skin sensibility is the proper test.

By touch, therefore, under the operation of the cohesive principle, we acquire fixed notions corresponding to the impressions made upon us by the objects that we handle. We contract a fixed impression of all the articles that we are in the custom of using. Thus a workman is familiarised with his tools ; and every person comes to know the instruments and furniture of their dwellings. But in order to appreciate the acquisitions of touch in their highest form, we must refer to the experience of the blind, who have no other sensation of solid and extended bodies excepting this. The impressions of sight are so much more enduring and revivable than any others that we hardly ever think of a visible body otherwise than as seen by the eye; a workman desiderating a hammer thinks, of its visible appearance, and not of its contact to his hand, although he is quite able to judge of it by this last feature. But the blind must *think* of objects as *felt* things; the revived sensation in them is a projection on the hands, not on the eyes, and they alone are in a position to judge, what is the natural permanence of skin impressions, and how far they can be recovered and lived in, when the reality is absent. Their thoughts, reveries, and dreams, are touches, not sights. Not only is their power of mere discrimination of a very exalted kind, but they attain the higher state of realizing past touches as if fully present; if, indeed, this realization of touch is under any circumstances fully attainable.

We must refer to the blind also for the association of trains, sequences, or succession of touches, made so coherent that any one can recall the entire chain. A blind man feeling his way along a wall by the hand, experiences in succession the different contacts; and, these by repetition, are so fixed in his mind, that, when he is placed at any one point, he anticipates all that is to follow. Being under the necessity of threading his way through life by touch, he acquires coherent successions of feelings of contact, as other men acquire of sights. He knows his whereabouts in room by touch; the progress of his work, if he is engaged in handicraft operation, is measured tactually.

22. In acquiring associations of Sounds, we have to encounter the supplanting tendency of the voice in the most interesting instances, namely, Articulate and Musical sounds. For while intently listening to a speech, we are very liable to follow the speaker with a suppressed articulation of our own, whereby we take the train of words into a vocal embrace, as well as receive it passively on the sense of hearing. The vocal association may possibly be the more effective of the two,

in constituting our subsequent recollection of what was said.

By repetition, as already observed in the other senses, the ear is formed to individual sounds, so as to enable them to remain with ease after the cessation of the cause. It always takes time to give the proper set and fixity to the nervous currents accompanying each separate impression, and this process is as much a result of the plastic force as the formation of chains of impressions.

The simplest sound is so far a complex impression, that it needs a plastic operation to fix its parts together. Thus an articulate syllable, *ma, ba,* is a really complex effect, occasioning a plurality of nervous currents; and to make all these flow together in company and order demands a certain length of repetition. We have already illustrated this under the agglutination of movements. The next stage is the coherence of trains or successions of sound, of which there are abundant examples. A simple air of music is a good illustration. Here a number of sounds follow one another in a fixed order; and by frequently hearing them, we learn to pass from the one to the other by ideal anticipation. The mental currents for one note fuse themselves into the next, and the one brings on the other by virtue of this acquired coherence. When a sufficient number of notes have been struck to determine the air, the musician can proceed with all the rest. His education is made up of many hundreds of these sequences, built up by degrees, under the plastic growth of the mind.

The determining circumstance in musical acquisition is the quality of the ear. The other circumstances—the natural adhesiveness, the concentration of mind through liking, the amount of repetition—are common to acquisitions generally. A fine ear is shown, in the first instance, by its delicacy of discrimination (with which is combined, in probably equal measure, the delicacy of the sense of agreement). It must be by virtue of the same superior quality in the organ, that sounds are more easily retained. All other things being the same, we cannot help supposing that a discriminative ear is also to the same degree a retentive ear. If so, we may assume discrimination as the test of superiority in this, or in any other sense, and may take for granted that retentiveness follows. Hence the explanation of a high power of acquisition would involve, first, General Adhesiveness; secondly, Concentration of Mind, through special liking or interest; and thirdly, the Local Endowment, of which the power of discrimination is to be accepted as a fair criterion.

Articulate sounds are made coherent on the same principle as musical sounds. The good articulate ear is, to some extent, a modification of the musical ear. In so far as the letters are distinguished by being combinations of musical tones, the two sensibilities must be the same. But seeing that this is not wholly the case, we are not prepared to say that they are so closely allied, that one may be always taken as evidence of the other. The facts would hardly bear us out in such an inference.

A third quality of vocal sounds is cadence or accent, the basis of elocution, oratory, and rhythmical composition, and constituting the individual and national varieties of accent. The ear retains not merely successions of articulate sounds, but also the cadence of their pronunciation; and when very susceptible to this class of effects, it shows itself in rapidly acquiring accent, in mimicry, and in the training in elocution suitable to the orator and the actor.

The associations in the ear are only a part of the several acquisitions of Music, Speech, and Elocution; but they are no doubt a considerable part.

23. Cohering trains and aggregates of the Sensations of Sight make, more than any other thing, perhaps more than all other things put together, the material of thought, memory, and imagination. That process of employing one sense as a substitute for others, principally avails itself of vision, the most retentive of them all. Thus it is, that objects thought of on account of their taste or smell, are actually *conceived* under their visual aspect. The image of a rose dwells in the mind

as a visual picture, and, in a very inferior degree, as a perpetuated impression of a sweet odour.

Sensations of sight, as we have seen, are compounded of visual spectra and muscular feelings. A visible picture is, in fact, a train of rapid movements of the eyes, hither and thither over luminous points, lines, and surfaces.

The education of the Eye goes through all the stages described for the other senses. There is, in the first place, a fixed set or familiarity with certain Colours, the result of repetition, enabling their impression to endure in the absence of the original, and to exist at any time of their own accord when once suggested.

The influence that gives the optical currents a facility in being induced and continued, so as to make one colour, as green, an object of comparison with other colours, is doubtless the same plastic power that forms aggregates of coloured expanse, connecting together a succession of tints, as a rainbow, or an optic spectrum. When we have passed repeatedly through the successive colours, the impression of one comes to induce the next, and that the following, and so on in order. But we can scarcely advance a step in this illustration, without bringing in the movements of the eye, and the feelings belonging thereto. I can suppose a case where the eyes, in a state of rest, have before them a number of colours produced in a fixed succession, flash after flash—red, orange, green, blue, violet, white, black, &c.—in which case a train of pure optical impressions would become fixed in the mind, and the occurrence of the first would tend to revive an image of the second third, &c., on to the last. The gradations of daylight and darkness are associated in this way. But in the ordinary case of associated colours, they exist side by side, as in the colours of the landscape, and here we move the eyes to see them, and thereby incorporate the act and feeling of Movement with the sensations of light. If the eye is in this way habituated to a train of colours, the habituation consists in this, that with each colour are associated both a movement of the eye and a second colour, and with this last movement and colour are connected a third movement and a new colour, and so on to the limit of the picture. If we suppose, for example, a chain of fields of different length and varying tints; the eye first sweeps over a yellow corn field, then passes to a grass field of double the length, then to a plantation of wood still longer; the image of the first is an impression of yellow accompanied with a definite sweep of the eye, and a corresponding continuance of the yellow impression; the image of the second is a green effect, doubly prolonged, or accompanied with a double sweep of the eye, or the head, or both; the third image is a different tint of green, imbedded in a still wider muscular sweep. In these circumstances, and after due repetition, if the eye is possessed of the proper yellow hue along with the definite movement of the eye accompanying it, the image of the first field will be re-instated, and the mental movement set, as it were, in an old and accustomed groove, and there will be a transition from the optical impression of yellow and a given expanse, to the optical impression of a shade of green with a double movement, and, lastly, to another shade of green with a still greater movement. These impressions will be re-induced, one after another, by the adhesive force of contiguous growth.

Let us divide the illustration of the detail into the two cases of Outline—Forms and Coloured Surfaces. In order to exemplify the class of Outline-Forms, we will suppose a white ring on a dark ground. Here we have a line of light and a round sweep of the eye concurring in one impression. The eye, following the ring, imbibes a continuous impression of light while performing a round movement; an optical and a muscular impression are conjoined in the effect, the muscular predominating; for the colour of the circumference is merely sufficient to give the lead to the ocular movement. The fixing of the impression depends, almost exclusively, on the cohesion of muscular impressions in the muscles of the eye. This case of the ring typifies a large class of important visual notions. The figures of geometry, the symbols or ciphers of Algebra, Chemistry, and the other symbolical sciences, the plans, diagrams, and outlines, used in the mechanical arts, all depend for their retention, in the first instance, on the purely muscular endowments of the eye. Written language furnishes another class of visible forms; and in the Fine Arts of Sculpture and Architecture, form is the chief matter of the artist's consideration.

The circumstances that favour this acquisition are, as before, partly general and partly special. The general adhesiveness of the system being assumed, there must be in the minds of some persons more than in others a special retentiveness for ocular movements. According to the general presumption above laid down, this would go along with a special power of discrimination lodged in those muscles, the consequence no doubt of a high development in the centres devoted to regulating their movements.

Next to the general and the local Retentiveness, we must advert to the mental concentration, as determined by special interest, taste, or liking, or a regard to the end to be served. We have quoted three different classes of outline forms, all equally retainable so far as the muscular retentiveness of the eye is concerned, but whose retention is stimulated by very different motives. These are Scientific forms, as the figures of Euclid; Arbitrary forms, as in written language; and Artistic forms. The attention to the first is prompted by whatever feelings constitute the scientific interest, or taste; the attention to the last grows out of the sensibility to Art; the second class, the arbitrary forms of language, are aided by our interest in the ends of language, either for ordinary purposes, or for the studies of the scholar. Looking at the peculiarities of these several cases, we can note that there is a greater concentration of mind upon the forms of Science and of Art, these being few and important, than upon the symbols of language, which are numerous and individually unimportant in the comparison. One would say that, in this last case, a high natural, disinterested, or unstimulated adhesiveness, would be more requisite than in the other classes of forms. A strong motive for concentrating the mind applies better to a few things requiring to be intensely held, than to a class of objects characterised by their multitude. The power of remembering a vast number of arbitrary visible marks may be set down as depending partly on a good general adhesiveness, and partly on the special muscular adhesiveness of the organ of vision. The acquiring of the Chinese language, with its many thousand characters, is perhaps the highest effort of this nature that any one has ever attempted. The geographical memory for maps falls under the same head; only in this instance there may be the prompting of a more powerful special interest.

24. Let us turn next to Coloured Surfaces, or those visual effects where light and shade, colour and lustre, are a material part of the impression, as in a landscape, a spectacle, a picture, a room, a human face. Here the object consists of an aggregate of masses of colour, which are associated by whatever force of retentiveness or adhesion belongs to the impressions of colour. If we repeatedly gaze at a picture, its different patches of colour seize hold of the mind and connect themselves in their natural order, so that the one can recall the rest, and the whole can exist and be held in the view, when the actual object is no longer present. Masses of coloured decoration, the colours of rich calicoes, and the variegated dresses of an assembly of people, exemplify the situation where colour predominates over form, and where the retentiveness is much more Optical than Muscular. The impressibility to colour is put to the test by the attempt to recall objects like these. This attribute has no necessary connexion with the muscular susceptibility; the two follow different laws, and belong to independent organs. In some people we find the luminous susceptibility powerful and pre-eminent; such persons have one of the gifts of a pictorial artist—painter or poet. The easy recollection or revival of scenes, and objects, and human faces, is necessary in order to work as a combiner in this kind of material.

25. As in other cases, the explanation of the superior retentiveness for coloured surfaces, is a combination of the

general adhesiveness with the local, modified by the circumstances that determine concentration of mind. A fine sense for shades of colour is a sufficient proof of a high local endowment, which will show itself in a corresponding power of retentiveness. There can be no reasonable doubt that the sense of colour is a distinct sensibility of the mind; and its consequences on the intellectual character are numerous and marked. It not only determines a facility of remembering scenes and pictures, and shades of colour; it also determines usually a strong interest in the concrete, pictorial, and poetic aspects of the world, and a repulsion to the scientific point of view, which deals with nature by means of abstractions and naked symbols. We are not to look for the aptitudes of abstract science in a mind highly sensitive to colour.

Besides, then, the positive conditions above enumerated of retentiveness to Form, we should add as a negative condition a moderate, or even inferior, susceptibility to Colour. The scientific man, the verbal scholar, and the artist in Forms will be all the more powerful in their respective walks, that the impressibility of the eye to colour is reduced to a minimum. The ordinary limits of the human mind do not permit a high development in two opposing kinds of talent.

SENSATIONS OF DIFFERENT SENSES.

The concurrence of Sensations in one common stream of consciousness,—in the same cerebral highway,—enables those of different senses to be associated as readily as the sensations of the same sense. We will now therefore review the more remarkable instances that arise out of this concurrence, and in so doing, it will be convenient to include Movements and their ideas along with Sensations.

29. *Movements with Sensations.*—Under this title I would quote the association of Actions with sensible Signs, as in all that department of lingual acquisition wherein names have the meaning of command, direction, guidance, control. Every movement that we make is connected with a certain form of words or a particular signal, for the purpose of setting it on

at any time. The child learns to connect vocal sounds with its various actions, and so becomes amenable to command and direction. This education is continued all through life, and the signs for indicating action may be varied without end. The notes of the bugle, the signals at sea, the directions posted up on the walls, have all this acquired power of commanding movements. The same association enters into the education of animals; the horse and the dog soon learn to connect specific actions with the language, tones, and looks of human beings. Long before children possess the power of utterance themselves, many of their actions are associated with the sounds of language as uttered by others.

30. *Muscular Ideas with Sensations.*—The enduring forms, impressions, or Ideas of Movement, are associated with Sensations, and the two things are thus disposed to recall each other. In the three higher senses we have seen that there is an association of these two elements; many tactile, audible, and visible sensations being a coalition of the two under Sight. We connect the visible appearances of objects with their weight, hardness, and tenacity,—qualities purely muscular in their perception. Having experience of the weight of a piece of stone of a certain appearance, we associate the appearance with the weight, and the one comes to recall the other; so with hardness or tenacity. In this way, we have an associated connexion between substances and their uses founded on these properties. We acquire a strong feeling of the difference between timber and stone, and between stone and metal, so much so that we demand each to be differently applied in all kinds of erections and mechanical operations. It has been remarked that our sense of Architectural proportions is founded on our experience of stone, and would require to be re-adjusted if iron were as universally employed. If the specific gravity of the rocky materials of the globe had been equal to lead, instead of being about two and half times water, our sense of the weight of every piece of stone would have been four times as great as at present, and we should consequently have demanded, for the satisfaction of

the eye, far more massive proportions in every kind of stone-work.*

31. *Sensations with Sensations.*—Under this head I might allude to all the combinations that would arise by taking each sense along with every other; organic sensations with tastes and smells, with touches, sounds, and sights; tastes with smells, &c.; smells with touches, and so on. But any reader may supply for himself examples of all these cases. I shall confine myself to the associations among the three higher senses.

Touches are associated with Sounds, when the ring of a body suggests how it would feel, as in discriminating stone, wood, glass, pottery, &c. This is a very abundant, and generally very secure, adhesion. The delicate discriminating power of the sense of hearing makes it thus a valuable means of knowing what is going on around us.

Touches are associated with Sights, in the great comprehensive case of connecting the tactile properties of things with their visible appearance, whereby the one can instantly suggest the other. We associate the tangible qualities of roughness, smoothness, solidity, liquidity, viscidity, with the characteristic impressions they make on the eye, and we can at any time recall the touch by the sight, or the sight by the touch. So we can distinguish metallic, wooden, or rocky surfaces; cloths, leaves, flowers, by both senses; and by association the impression on the one can bring up the other. Each person has a large amount of knowledge existing in the shape of associated touches and sights. We connect likewise the form, as revealed to the touch, with the visible forms, and thus make the one confirm the other. Our notion of Figure is in fact a coalition of different impressions, and this gives

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* That is, supposing there was no increased tenacity, or power to resist crushing. Iron buildings are less massive than stone, notwithstanding the greater density of the material; but in this case the greater strength of the substance comes into play, and the employment of hollow and slender forms takes off from the weight to be supported.

to it a more perfect character than any single impression can convey. I shall speak of this again presently.

Sounds are associated with Sights in innumerable instances. We connect the visible appearances of bodies with the noise they make when struck, as a glass, a spoon, a book, a hat. We associate an instrument of music with the peculiar quality of its note; we connect animals with their vocal utterance. So with human beings; every person known to us having a distinctive voice. In acquiring languages, this association is exemplified in two ways. Every visible object is connected with the sound of its name—sun, mountain, house, &c. And in learning to read, the audible names are associated with the written and printed characters.

32. In such a case, and in all the other cases of heterogenous association, I am disposed to think that the *rapidity of the adhesion* will vary with the adhesive quality of each of the two senses entering into the combination. Thus, when sounds are connected with sights, the goodness of the ear and the retentiveness of the eye will both contribute to make the adhesion quick and sure. Whence all associations with sight would come sooner to maturity than the connexions formed among the inferior sensations. This circumstance it is that puts sight forward as the representative sense. Things that are seen having a more glorious resurrection in the mind than any others, we choose to conceive the objects of nature as they appear to the eye, rather than as they affect the ear or the touch. Of all the ways that an orange can strike the senses, the visible aspect is by pre-eminence its revived manifestation, in other words, its 'idea.'

OF EXTERNAL PERCEPTION—THE MATERIAL WORLD.

33. The perception and the knowledge of the material world come through the muscular feelings and the sensations, by their association with one another. The manner of attaining to this knowledge, its exact nature and the degree of certainty attaching to it, give rise to some of the greatest questions of metaphysical philosophy. Two problems especially call

for notice at this stage. The first is the origin of the perceptions we owe to vision, namely, the Forms and Magnitudes of External Bodies, and their Distances from the eye. Ever since these perceptions were affirmed by Berkeley to be not original, but acquired, they have formed a subject of discussion with metaphysical writers. The second question relates to the grounds we have for asserting the existence of an External and Material World; this question grew out of the other both historically and naturally, and was one of the prominent metaphysical questions of the eighteenth century.

34. *Of the Perception of the Distances and Magnitudes of External Bodies.*—In speaking of the sensations of vision, we have adverted to the qualities of Colour, Form, and Solid Dimension, of which the eye gives us feelings or impressions. It is to be seen how far these last, together with Distance and Magnitude, are original and proper to the eye, and how far the result of a fusion of eye-sensations with other feelings.

The distinctive impressibility of the eye is for Colour. This is the effect specific to it as a sense. But the feeling of Colour by itself, implies no knowledge of any outward object, as a cause or a thing wherein the colour inheres. It is simply a mental effect or influence, a feeling or conscious state, which we should be able to distinguish from other conscious states, as for example, a smell or a sound. We should also be able to mark the difference between it and others of the same kind, more or less vivid, more or less enduring, more or less voluminous. So we should distinguish the qualitative differences between one colour and another. Pleasure or pain, with discrimination of intensity and of duration, would attach to the mere sensation of colour. Knowledge or belief in an external or material coloured body, there would be none.

But when we add the Active or Muscular sensibility of the eye, we obtain new products. The sweep of the eye over the coloured field gives a feeling of a definite amount of *action*, an exercise of internal power, which is something totally different from the passive feeling of light. This action has many various modes, all of the same quality, but all distinctively felt and recognised by us. Thus the movements may be in any direction—horizontal, vertical, or slanting; and every one of these movements is felt as different from every other. In addition to these, we have the movements of adjustment of the eye, brought on by differences in the remoteness of objects. We have distinctive feelings belonging to these different adjustments, just as we have towards the different movements across the field of view. If the eyes are adjusted first to clear vision for an object six inches from the eye, and afterwards change their adjustment to suit an object six feet distant, we are distinctly conscious of the change, and of the degree or amount of it; we know that the change is greater than in extending the adjustment to a three-feet object, while it is less than we should have to go through for a twenty-feet object. Thus in the alterations of the eyes for near and far, we have a distinctive consciousness of amount or degree, no less than in the movements for right and left, up and down. Feelings with the character of activity are thus incorporated with the sensibility to colour; the luminous impression is associated with exertion on our part, and is no longer a purely passive state. We find that the light changes as our activity changes, we recognise in it a certain connexion with our movements; an association springs up between the passive feeling and the active energy of the visible organ, or rather of the body generally; for the changes of view are owing to movements of the head and trunk, as well as to the sweep of the eye within its own orbit.

We have not yet attained to the perception or knowledge of any outward thing as the source of colour, or as the occasion of the varying movements and adjustments of the eyes. We have discriminating feelings of colour, the discriminative sense of active energies, and the association of the two in one fact, but nothing to reveal or suggest external things; we have merely the means of comparing a number of various mental states. Nor do I see how, with the eye alone, we can ever pass from the internal consciousness to the external perception—to the recognition, knowledge, and belief of things out of, or apart from, ourselves, the causes of those internal states. Many have contended for, and many more assumed, this power as attaching to vision. But in so doing, they seem to me to have fallen into a confusion of idea respecting the mental nature of this perception of an outer world, as I shall now endeavour to explain.

35. It is, I believe, admitted on all hands, that the recognition of a world apart from self is mixed up with the perception of such qualities as Extension, Form, and Remoteness, called *Primary* qualities of matter. Heat, Odour, Taste, Colour alone, do not suggest external and independent objects, being for this reason termed the *Secondary* qualities of bodies. I shall fasten, therefore, on the two facts of Distance and Extension, both which imply outward existence, in so far as we recognise and believe in the reality of a material world apart from the mind. With regard to those two qualities,—the distance of a thing from the seeing eye and the dimensions of a body in space,—I affirm that they cannot be perceived or known through the medium of sight alone.

Take first the case of Distance, or remoteness. It appears to me that the very *meaning* of this quality,—the full import of the fact implied in it,—is such as cannot be taken in by mere sight. For what do we mean when we say that an object is four yards distant from where we stand? I imagine that among other things we understand this, namely, that it would take a certain number of paces to come up to it, or to reduce the distance from four yards say to one yard. The possibility of a certain amount of locomotion is implied in the very idea of distance. The eye would be distinctly aware of a change, when the distance was reduced from four yards to one, but it has of itself no knowledge of the cause or accompanying incidents of that change. These are measured by our other activities, and in the case of great distances, by the locomotive energy and continuance requisite to pass from the one to the other. In the case of objects within reach of the hand, the movements of the arm give the measure of distance; they supply the accompanying fact that makes distance something more than a mere visible impression. When we say, that a thing has been shifted from a position of six inches distance from the eye to a position of twelve, we imply that with the change of ocular effect, there has been another change corresponding to a certain definite movement of the hand and arm in a forward direction; and, unless by supposing this additional action, we have no key whatever to the alteration that has come over our visible image. I say, therefore, that distance cannot be perceived by the eye, because the idea of distance, by its very nature, implies feelings and measurements out of the eye, and located in the other active organs,—the locomotive and other moving members. If our notion of distance did not reveal to us the fact that by so many steps, or by a certain swing of the arm or bend of the body, we should make a definite change in the appearance of the object, it would not be a notion of distance; there might be an ocular effect, but not a revelation of distance. Granting that the eye is very distinctly affected by every change in the remoteness of a visible object from six inches to a mile, that it recognises a variation of impression all through this interval, this would not answer the question, how far is the object removed at each step? I do not see even how it could tell which way the thing was moving. The actual distance means so many inches, feet, or yards, and of these we have no measure by the eye; indeed they have no relevancy as regards the eye; they concern the locomotive and other mechanical movements, but not the movements of sight.

With the active exertion of the body in locomotion we have a definite muscular feeling; we recognise one exertion as greater or less than another; the feeling of a long stride is different from a short; six paces are attended by a different consciousness from four. We acquire permanent and revivable impressions of these exertions when any one has been often repeated, as for example, pacing the length of a room. We can compare any new case with this old habitual effort, and there results a consciousness of more and less. This I take to be our starting point in the feeling of distance traversed, or of linear extension in general : this is the source of our perception, and the measure and standard of reference, when we arrive at the same notion by other means. When, along with a forward movement, we behold a steadily varying change of appearance in the objects before us, we associate the change with the locomotive effort, and after many repetitions, we firmly connect the one with the other. We then know what is implied in a certain feeling in the eye, a certain adjustment of the lenses and a certain inclination of the axes, of all which we are conscious ; we know that these things are connected with the *further experience* of a definite locomotive energy needing to be expended, in order to alter this consciousness to some other consciousness. Apart from this association, the eye-feeling might be recognised as differing from other eye-feelings, but there would be no other perception in the case. Experience connects these differences of ocular adjustment with the various exertions of the body at large, and the one can then imply and reveal the others. The feeling that we have when the eyes are parallel and vision distinct, is associated with a great and prolonged effort of walking, in other words, with a long distance. An inclination of the eyes of two degrees, is associated with two paces to bring us up to the nearest limit of vision, or with a stretch of some other kind measured in the last resort by pacing, or by passing the hand along the object. The change from an inclination of 30° to an inclination of 10°, is associated with a given sweep of the arm, carrying the hand forward over eight inches and a half.

It thus appears that Distance from the eye, and linear extent in any direction, severally import certain definite bodily movements, experienced in connection with the changes of visible impression in passing from one point to another.

36. If we next attend to the sweep of the eye over the field of view, as required by an object extended laterally, we shall find, in the same manner, that this sweep gives a most dis-

tinctive consciousness, so that a larger sweep can be discriminated from a smaller; but it gives no information besides. It tells of no outward thing, so far as I can make out; certainly it does not tell of extension, for this simple reason, that extension means a given movement of the body. If I say that a log of wood I see before me is six yards long, I mean that it would take a certain number of my paces to traverse its length: the visual impression of itself cannot mean or imply any fact of this kind, until experience has connected the sweep of the eye with the sweep of the legs or other moveable parts.

Accordingly, I hold, as regards Extension in general, that this is a feeling derived in the first instance from the locomotive or moving organs; that a definite amount of movement of these comes to be associated with the sweep and adjustments and other effects of the eye; and that the notion when full grown is a compound of locomotion, touch, and vision, any one implying and recalling the others. A certain movement of the eye, as the sweep over a table, gives us the sense of that table's magnitude, when it recalls or revives the extent and direction of arm movement necessary to compass the length, breadth, and height of the table. Previous to this experience, the sight of the table would be a mere visible effect, differing consciously from other visible effects, as one stomachic pain differs from another, but not suggesting any foreign effect whatever. It could not suggest magnitude, because magnitude is not magnitude, if it do not mean the extent of movement of the arms or limbs that would be needed to compass the object; and this can be gained in no way but through actual trial by these very organs.

37. The conclusion, therefore, is that Extension, size, or magnitude, owes, not only its origin, but its essential import, or meaning, to a combination of different effects associated together under the cohesive principle we are now considering. Extension, or space, as a quality, has *no other* origin and no other meaning than the association of these different sensitive and motor effects. The coalition of sensations of sight and

touch with felt motive energies, explains everything that belongs to our notion of extended magnitude or SPACE.

This view has both its supporters and its opponents. Of the opposition, I shall content myself with referring to Sir William Hamilton, who expresses himself on the subject in the following terms :—'The opinions so generally prevalent, that through touch, or touch and muscular feeling, or touch and sight, or touch, muscular feeling, and sight,—that through these senses exclusively, we are percipient of extension, &c., I do not admit. On the contrary, I hold that all sensations whatsoever, of which we are conscious, as one out of another, *eo ipso*, afford us the condition of immediately and necessarily apprehending extension; for in the consciousness itself of such reciprocal outness is actually involved a perception of difference of place in space, and, consequently of the extended.'—*Dissertations on Reid*, p. 861. The statement here made that all sensations, of which we are conscious as one out of another, afford a condition of apprehending extension, seems to me to imply and take for granted the point in dispute : for I do not see how one sensation can be felt as out of another, without already supposing that we have a feeling of space. If I see two distinct objects before me, as two candle flames, I apprehend them as different objects, and as distant from one another by an interval of space ; but this apprehension presupposes an independent experience and knowledge of lineal extension. There is no evidence to show that, at the first sight of these objects, and before any association is formed between visible appearances and other movements, I should be able to apprehend in the double appearance a difference of place. I feel a distinctness of impression, undoubtedly, partly optical and partly muscular, but in order that this distinctness may mean to me a difference of position in space, it must reveal the additional fact, that a certain movement of my arm would carry my hand from the one flame to the other, or that some other movement of mine would change by a definite amount the appearance I now see. If no information is conveyed respecting the possibility of movements of the body generally, no idea of space is given, for we never consider that we have a notion of space, unless we distinctly recognise this possibility. But how a vision to the eye can reveal beforehand what would be the experience of the hand or the other moving members, I am unable to understand.*

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* In following a wide ranging movement, or, in expatiating over a large prospect, we must move the eyes, or the head; and probably every one would allow that, in such a case, feelings of movement make a part of our sensation and our subsequent idea. The notion of a mountain evidently contains feelings of visual movement. But when we look at a circle, say, one tenth of an inch in diameter, the eye can take in the whole of it without movement, and we might suppose that the sensation is, in that case, purely optical, there being no apparent necessity for introducing the muscular consciousness. A characteristic optical impression is produced; we should be able to discriminate between the small circle and a square, or an oval; or between it and a somewhat larger or a somewhat smaller circle, from the mere optical difference of the effect on the retina. Why then may we not say,that, through the luminous tracing alone, we have the feeling of visible form?

By making an extreme supposition of this nature, it is possible to remove the case from a direct experimental test. We may still, however, see very strong grounds for maintaining the presence of a muscular element even in this instance. In the first place, our notions of form are manifestly obtained by working on the large scale, or by the survey of objects of such magnitude as to demand the sweep of the eye, in order to comprehend them. We lay the foundations of our knowledge of visible outline in circumstances where the eye must be active, and must mix its own activity with the retinal feelings. The idea of a circle is first gained by moving the eye round some circular object of considerable size. Having done this, we transfer the fact of motion to smaller circles, although they would not of themselves demand an extensive ocular sweep. So that when we look at a little round body, we are already pre-occupied with the double nature of visible form, and are not in a position to say how we should regard it, if that were our first experience of a circle.

But, in the second place, as remarked in the text, the essential *import* of visible form is something not attainable without the experience of moving the eye. If we looked at a little round spot, we should know an optical difference between it and a triangular spot; and we should recognise it as identical with another round spot, but that is merely retinal knowledge, or optical discrimination. That would not be to recognise form, because by form we never mean so little as a mere change of colour. We mean by a round form something that would take a given sweep of the eye to comprehend it; and unless we identify the small spot with the circles previously seen, we do not

The conjoint experience of the senses and the movements appears to me to furnish all that we possess in the notion of Extended matter. The association between sight and locomotion, or between touch and the movements of the arm, tells us that a given appearance implies the possibility of a certain movement; that a remote building implies a certain continuance of our walking exertions to change its appearance into another that we call a near view; and the power of motion, the scope for moving, exhausts every property in the idea of empty space. We estimate it first by our own movements, and next by other movements measured in the first instance by our own, as for example, the flight of a bird, the speed of a cannon ball, or the movement of light. The mental conception that we have of empty Space, is *scope for movement*, the possibility or potentiality of moving; and this conception we derive from our experience of movements. The *resistance to movement* is our notion of a Plenum or occupied space; the *extent of movement* is our measure of the linear Extension of body or extended Magnitude. No internal revelation, nothing in the nature of intuition or innate conception, is required for giving us such notions as we actually have of these qualities.

Perception and Belief of the Material World.

38. Inasmuch as knowledge and perception inhere in mind alone, it has been asked whether there be anything else than mind and its activities in the universe; or what reason have we for believing in the existence of counterpart objects apart from, and independent of, our sensations. May not waking thought be itself a dream? On this question the following remarks are submitted.

(1.) There is no possible knowledge of the world except in reference to our minds. Knowledge means a state of mind;

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perceive it to be a circle. It may remain in our mind as a purely optical meaning; but we can never cross the chasm that separates an optical meaning from an effect combining light and movement, in any other way than by bringing in an experience of movement.

the notion of material things is a mental thing. We are incapable of discussing the existence of an independent material world; the very act is a contradiction. We can speak only of a world presented to our own minds. By an illusion of language, we fancy that we are capable of contemplating a world which does not enter into our own mental existence; but the attempt belies itself, for this contemplation is an effort of mind.

Nevertheless, we are accustomed to divide the act of cognition, or knowledge, into two parts,—a something knowing, and a something known. In Sensation, we have the sentient mind, and the thing felt, *sentiens* and *sensum*. Some account must be rendered of this twofold nature of sense and knowledge. If the something that knows, feels, perceives, be called mind, what is the other something that is known, felt, perceived?

(2.) Solidity, Extension, and Space,—the foundation properties of the material world,—mean, as has been said above, certain movements and energies of our own body, and exist in our minds in the shape of feelings of Force allied with Visible, and Tactile, and other sensible impressions. The sense of the External is the consciousness of particular energies and activities of our own.

If we were the subjects of purely passive sensation,—such sensations as warmth, odour, light,—apart from any movement of any active member whatever, our recognition of the external world might be something very different from what we now experience. The state of the consciousness would then, so far as we are able to imagine it, be of the nature of a dream, and our perception of the universe would be sufficiently represented by a theory of idealism.

But in us, sensation is never wholly passive, and in general is much the reverse. Moreover, the tendency to movement exists before the stimulus of sensation; and movement gives a new character to our whole percipient existence. The putting forth of energy, and the consciousness of that energy, are facts totally different in their nature from pure sensation;

meaning thereby sensation without activity, of which we can form some approximate idea, from the extreme instances occurring to us of impressions languidly received.

It is in this exercise of Force that we must look for the peculiar feeling of *externality* of objects, or the distinction that we make between what impresses us from without and impressions not recognised as outward. Any impression on the senses that rouses muscular energy, and that varies with that energy, we call an *outward* impression. Dr. Johnson refuted Berkeley, as he thought, by kicking a stone. In fact, this action of Johnson's illustrates the real nature of our recognition of externality. It was his own exertion with its consequences, and not the optical impression of a stone on the eye, that satisfied him as to the existence of something outward. The sum total of all the occasions for putting forth active energy, or for conceiving this as possible to be put forth, is our external world.

Taking the order of the senses followed in our exposition in the previous book, Touch is the first that decidedly makes us cognizant of an external world. But if we were confining ourselves to the class of sensations of soft touch, where we have the passive pleasure of the sense in highest perfection, we should not find much superiority in this sense over smell, in the matter now under consideration. It is *hard contact* that suggests externality; and the reason is that in this contact we put forth force of our own. The more intense the pressure, the more energetic the activity called forth by it. This mixed state, produced through reacting upon a sensation of touch by a muscular exertion, constitutes the *sense of resistance*, the feeling that is the principal foundation of our notion of externality. 'There is no feeling of our nature of more importance to us than that of resistance. Of all our sensations, it is the most unintermitted; for, whether we sit, or lie, or stand, or walk, still the feeling of resistance is present to us. Everything we touch at the same time resists; and everything we hear, see, taste, or smell, suggests the idea of something that resists. It is through the medium of resistance that every act, by which we subject to our use the objects and laws of nature, is performed. And of the complex states of consciousness, there is hardly one in which the feeling or idea of resistance is not included.'* In fact, we constantly carry about with us the feeling or the notion of resisting, in other words, the state where a sensation of touch is coupled with the putting forth of effort or force.

The main consideration, therefore, in this great question is, that the totality of our mental life is made up of two kinds of consciousness—the object consciousness and the subject consciousness. The first is our external world, our *non-ego;* the second is our *ego,* or mind proper. Berkeley confounded these two : he merged the object consciousness, determined by our feelings of expended energy, in the subject consciousness, determined by passive feelings and ideas. It is quite true that the object consciousness, which we call Externality, is still a mode of self in the most comprehensive sense, but not in the usual restricted sense of 'self' and 'mind,' which are names for the subject, to the exclusion of the object.

(3.) We experience certain uniformly recurring sensations, and certain uniform changes n these, when we exert particular energies. Thus the visible picture of our dwelling is a permanent and habitual experience, and the variations it is subject to, correspond principally to our own conscious movements. But at times the appearance is entirely withdrawn, and exists only in memory or idea. We then feel the difference between the two experiences, the ideal and the actual, and we assign some superiority in the mode of existence of the one over the other. The superiority we soon find to connect itself with the changes due to our movements ; a mere picture or *idea* remains the same whatever be our bodily position or bodily exertions ; the sensation that we call the *actual* is entirely at the mercy of our movements, shifting in every possible way according to the varieties of action that we go through. With a forward movement the visible impression

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* MILL'S *Analysis of the Human Mind,* vol. i. p. 47.

enlarges, with a backward movement it diminishes. A movement of the eye shuts it off, another movement restores it. The carriage of the head alters it from side to side; the bending of the body varies it in other ways. We are constrained to make a distinction between the things that are thus shifted by all our movements, and the ideas or dreams that vary of themselves while we are still. Even if sensation were only in ourselves, we should still have to distinguish between present sensation and remembered or revived sensation; the reference of the one to our voluntary movements, and of the other to no such modifying causes, would oblige us to note a vital difference in the two classes of facts. Such is the uniformity of connexion between certain appearances and certain movements, that we come to anticipate the one through the other. We know that in some one position, as when lying in bed, a movement of the limbs will bring us to the sensation of a solid contact in the feet; that another series of movements will bring on a particular view to the sight; that a third movement will bring the sound of a bell to the ear, and so forth. We recognise all those sensible effects, thus brought uniformly into play by a regular series of waking voluntary actions, as totally different from our ideas, recollections, and dreams.

(4.) As our belief in the externality of the causes of our sensations means that certain actions of ours will bring the sensations into play, or modify them in a known manner, this belief is easily furnished to us by experience; it is no more than our experience entitles us to entertain. Having felt again and again that a tree becomes larger to the eye as we move; that this movement brings on at last a sensation of touch; that this sensation of touch varies with movements of our arm, and a great many other similar coincidences; the repetition of all this experience fixes it in the mind, and from the sight alone we can anticipate all the rest. We then know that our movements will bring about all the changes and sensations above described, and we know no more; but this knowledge is to us the recognition of external existence, the only thing, so far as I see, that external existence can possibly mean. Belief in external reality is the anticipation of a given effect to a given antecedent; and the effects and causes are our own various sensations and movements.

(5.) When we find that one fixed set of movements brings on at the same time *sensations of various senses*,—as when approaching to an orchard we have sights and sounds and touches and smells and tastes,—the fact very much enhances the notion we have of the *dependence of sense on action or movement*, the richness, so to speak, of the external world, the value of our action as bringing on sensation. Moreover, when successive movements bring forward endless varieties of new sensations, we are in this way also impressed with the abundance of effect brought on as a consequence of our own movement. We see the largeness of the possible world as compared with the appearance that self makes,—the expanse of our own body,—which is to us a unit of comparison and standard of reference. Whether the causes of appearances are external to our mind or not, we are at all events certain that they are external to our bodies; for between the world and each one's corporeal presence a comparison is possible: between the world and mind there is no comparison, the things are not homogeneous. We incur the absurdity of converting mind into a substance to be viewed by another mind, when we speak of our perceiving faculty as an extended thing. But a world extending beyond our own person we can understand; it implies that the movement that traverses the body must be many times multiplied to traverse the world, that is to bring forward the whole array of possible changes of sensation.

(6.) When we come to communicate with other beings, and ascertain by the signs of communication that they pass through the same experience as ourselves, this enhances still more the constancy of the association between our sensations and the corresponding active energies. We ascertain that, at times when we ourselves are not affected by a particular sensation, as of light, other persons are affected by it. This leads us to generalize sensation still more, and to form to ourselves an *abstraction* that comprehends all our experience, past and present, and all the experience of others, which abstraction is the utmost that our minds can attain to respecting an external and material world. So often as I open my eyes I have the sensation of light (the exceptions are not material to the illustration). I thereupon associate this sensation with this action, and I expect in all future time that the action will lead to the sensation. Other persons tell me the same thing. I thereupon affirm as a general fact, that an optical feeling will always follow a certain muscular feeling, to me and to other sentient beings; and I can affirm nothing more, nor can I have any possible interest or concern with anything more. The assertion that light and the sun have a permanent and independent existence has, for its basis and for its import, that I and all other beings with whom I have had any communication, have had a certain optical feeling in conjunction with certain activities of which we have been conscious, and firmly anticipate the same coincidence in the future. The external existence of a stone wall means the association between certain optical impressions and a particular locomotive effort, and a further and still more decided association between touch and another effort, that, namely, which we call the sense of resistance. Finding the same sequence to exist with reference to beings in general, we generalize the fact to the very farthest limits, and affirm that it has always been so in the past, and will always be so in the future. Our language is apt to go beyond this; out of all the *particular* experiences (which alone constitute the real evidence for the proposition) we construct an experience in the *abstract*, a most anomalous fiction, that goes the length of affirming that the sensation is not only sure to occur along with the appropriate actions, but that it exists whether these actions take place or not. We seem to have no better way of assuring ourselves and all mankind that with the conscious movement of opening the eyes there will always be a consciousness of light, than by saying that the light exists as independent fact, with or without any eyes to see it. But if we consider the case fairly, we shall see that this assertion errs not simply in being beyond any evidence that we can have, but also in being a self-contradiction. We are affirming that to have an existence out of our minds which we cannot know but as in our minds. In words, we assert independent existence, while in the very act of doing so, we contradict ourselves. Even a possible world implies a possible mind to perceive it, just as much as an actual world implies an actual mind. The mistake of the common modes of expression in this matter, is the mistake of supposing the abstractions of the mind to have a separate and independent existence. This is the doctrine of the Platonic 'ideas,' or 'forms,' which are understood to impart all that is common to the particular facts or realities, instead of being derived from them by an operation of the mind. Thus the actual circles of nature derive their mathematical properties from the pre-existing 'idea,' or circle in the abstract; the actual men owe their sameness to the ideal man. So, instead of looking upon the doctrine of an external and independent world as a generalization or abstraction grounded on our particular experiences, summing up the past, and predicting the future, we have got into the way of maintaining the abstraction to be an independent reality, the foundation, or cause, or origin of all those experiences.

Thus, then, the *sentiens* and the *sensum* are but the two contrasting modes of our conscious existence. In passive feeling, we are in one mode of existence, in putting forth active energy, we are in another mode. A sensation is properly speaking a *sensum*, a phase of our objective consciousness. When we say that to this *sensum* there must correspond, from the necessity of the case, a *sentiens*, our meaning is that the same being, now all sensation, exists in another phase, the phase of passive feelings and ideas; that what is sensation at this moment may be idea in the next moment, and may concur in the same stream of consciousness with ideas and feelings. We live a double life, of object states and of subject states. The *sentiens*, or the mind that feels, is one portion of the totality of our being; the *sensum*, the thing felt, is the alternative or contrasting portion of our being, the attitude of putting forth actual energy. It is not necessary to the validity of the contrast, that we should be both subject and object in the same instant ; the principle of the essential Relativity of all knowledge, does not require that both elements of every contrasting couple should be always present. It is enough that one is actually present, and that the other has been previously present (the more recently the better). We are rarely in a pure object-state ; but, on many occasions, we are in a pure subject-state, being all passivity and ideas.

The amount of constant dependence of the *non-ego* upon the *ego*, the need there is for a *sentiens* to accompany each attitude of *sensum* may be elucidated by attending to other subject and object relations, besides the great and cardinal relation between the Unextended Mind and the Extended and external world. I, the subject, may be at times an object ; I may make my own mental states, my passive feelings, and my successions of thought, a matter of study and consideration, as in the investigations of mental science. Properly speaking, at that moment I am all subject ; I have withdrawn myself so completely from the cognition of the object world, that no part of me is then an object in the chief acceptation of object—the *non-ego,* or the extended material world. But within the subject sphere, in which I exclusively am for the time, I might be said to be divided into two parts, the recollections of my feelings or states, which I am studying, and the act of studying them ; the one, the facts studied, is, in a certain sense, an object ; the other, the effort of studying, is the subject. So, when engrossed in remembering, I am all subject, since what I remember is some idea or ideas, and my act of remembering is also called a part of my *ego* or self. These cases will show what there is of the *ego* in the *sentiens*, as something accompanying the *sensum*. The ego, in these instances, is a *voluntary effort or act ;* and all such voluntary acts are prompted by some *feeling*, in the strict subjective sense, some pleasure or pain. Whenever we are acted on by a feeling, we are in a subject-state ; and hence our external perceptions, or our sensations of the object world, have this much of the subject usually going along with them, that they are moved by some truly subject-state. This is not an absolute, unvarying necessity ; we may, by mere spontaneous activity, or habit, be cognizant of external things ; there may be no volition in the proper form ; and in the further absence of any ideas or passive feelings, or any special enjoyment of the pleasure of exercise, we should be all *sensum*, and no *sentiens*. If a *sentiens* were still to be affirmed as implied in the fact of a *sensum*, it would amount to no more than this, that the two inhere in the same being, which they divide between them, and are never long separated. For it must be farther conceded, that the absence of a true manifestation of the *sentiens* from an attitude of the *sensum* is rare and exceptionable. Whenever perception as a voluntary act exists, subjectivity as feeling must be present to give the motive. And farther, whenever the sensation is felt as passing into the idea, that is, if we cease from the active effort of attention, and pass into the state of remembering what we have just perceived, we are relaxing our attitude of *sensum* in favour of a mode of *sentiens*.

'It is this participation of the subject in every act of *will*, that enables us to make a minor subject and object distinction, when any part of our *ego* is studied by us ; and when we remember, reason, or imagine—all which operations fall wholly within our subjectivity. Inasmuch as we are specially in a subject state when a motive to the will is present, our voluntary promptings are, in relation to our remembered feelings and ideas, a more determined subjectivity ; and the remembered states themselves are the co-relative objects. Thus while *sentiens* and *sensum*, or *percipiens* and *perceptum*, may be said to mark the great and vital distinction of subject and object, Mind and the Extended, *cognoscens* and *cognitum*, may express a subject and object distinction made within the subject, a distinction of far inferior importance, and of a transient nature, grounded on the more peculiarly subject character of the states that move the will, as compared with other states that have no present motive efficacy. There is the same element of pure subjectivity in *cognoscens* as in *sentiens*, and we so far apply the analogy, as to divide ourselves into two parts in both cases ; but the division has a very different importance in the introspective cognition, and in the *sensum* or *perceptum* of the Extended.'

39. Having touched on the metaphysical disputes concerning the first origin and precise import of our notions of distance and extension, I must now advert to the exact process whereby we come to be cognizant by sight, of those properties that are out of the sphere of its immediate recognition. The relations between these four distinct facts, namely, Ocular

Adjustment for seeing an object, the Extent of the image on the retina, the Distance, and the true Magnitude of the object, are what we have to consider; for we find that in the educated eye these circumstances are suggestive of one another. On this subject I shall avail myself of the observations of Professor Wheatstone, in his Bakerian Lecture, contained in the *Philosophical Transactions* for 1852. The question to be solved is, how do we come to connect a certain felt effect on the eye, with a knowledge of the distance and size of the object causing the impression; as when we say that a lamp-post is twenty feet off, or that a distant wood is within three or four miles. When the gaze is still, the optical impression implies no more than these two facts,—a certain effect of light and colour, and an adjustment of the eyes singly and conjointly; when the gaze is wandering, the movements and changes of adjustment operate in addition.

'Under the ordinary conditions of vision, when an object is placed at a certain distance before the eyes, several concurring circumstances remain constant, and they always vary in the same order when the distance of the object is changed. Thus, as we approach the object, or as it is brought nearer to us, the magnitude of the picture on the retina increases; the inclination of the optic axes required to cause the pictures to fall on corresponding places of the retinæ, becomes greater; the divergence of the rays of light proceeding from each point of the object, and which determines the adaptation of the eyes to distinct vision of that point, increases; and the dissimilarity of the two pictures projected on the retinæ also becomes greater. It is important to ascertain in what matter our perception of the magnitnde and distance of objects depends on these various circumstances, and to inquire which are the most and which the least influential in the judgments we form. To advance this inquiry beyond the point to which it has hitherto been brought, it is not sufficient to content ourselves with drawing conclusions from observations on the circumstances under which vision naturally occurs, as preceding writers on this subject mostly have done, but it is necessary to have more extended recourse to the methods so successfully employed in experimental philosophy, and to endeavour, wherever it be possible, not only to analyse the elements of vision, but also to re-combine them in unusual manners, so that they may be associated under circumstances that never naturally occur.'—p. 2.

Accordingly, Mr. Wheatstone has devised an instrument, being a modification of his reflecting stereoscope, whereby he can expose pictures to the two eyes in such a manner that the Distance can be changed while the Convergence of the two eyes remains the same, or the Convergence be altered while the Distance remains the same, thus disassociating two effects that constantly go together in ordinary vision. The result of the experiments showed the influence of both circumstances, namely, the Convergence of the eyes and the Size of the picture on the retina (which is greater as the object is nearer), in determining our judgment of Distance. He finds that, the distance of the object remaining the same, the greater convergence of the two eyes makes the object seem smaller, this increased convergence being required in ordinary vision when a thing is brought nearer. It appears, therefore, that while the retinal magnitude is unaltered, greater convergence gives a perception of smaller Size. On the other hand, leaving the inclination of the axes unchanged, and bringing the pictures nearer, thereby increasing the picture on the retina, we have a perception of increased Size in the object. 'The perceived magnitude of an object, therefore, diminishes as the inclination of the axes becomes greater, while the distance remains the same; and it increases when the inclination of the axes remains the same, while the distance diminishes. When both these conditions vary inversely, as they do in ordinary vision when the distance of an object changes, the perceived magnitude remains the same.'

Thus, as regards the perception or appreciation of the real *magnitudes* of objects seen by the eye, the association lies between a certain magnitude (ascertained by other means than sight), and a certain inclination of the optic axes with a given size of the picture on the retina. Thus the image of a man, of which we have a certain muscular estimate by our movements, when viewed at some one inclination of the optic axes, yields an image on the retina of a particular size; with such inclination and size of image we associate the muscular appreciation of an object six feet high, &c. The concurrence of these two conditions always suggest a similar magnitude or extent of the thing viewed. And if the optic inclination is made smaller, that is, if the axes of the eyes approach more to parallelism, while at the same time the image on the retina is correspondingly less, as by removing the object to a greater distance, there will still be a perception of the same size, or the same muscular appreciation will be suggested to the mind. We have an association of the size of a man with a great many different combinations of those two circumstances, produced by variation of actual distance.

40. And next, as respects our perception and estimate of *distance*, or the suggestion of a given locomotive exertion with a visual appearance. On this head Mr Wheatstone's observations are somewhat different from the received views. He considers that the appreciation of distance, instead of preceding the estimate of magnitude, *follows* it. 'It is the prevalent opinion that the sensation which accompanies the inclination of the optic axes immediately suggests distance, and that the perceived magnitude of an object is a judgment arising from our consciousness of its distance and of the magnitude of its picture on the retina. From the experiments I have brought forward, it rather appears to me that what the sensation which is connected with the convergences of the axes immediately suggests, is a correction of the retinal magnitude to make it agree with the real magnitude of the object, and that distance, instead of being a simple perception, is a judgment arising from a comparison of the retinal and perceived magnitudes. However this may be, unless other signs accompany the sensation of convergence, the notion of distance we thence derive is uncertain and obscure, whereas the perception of the change of magnitude it occasions is obvious and unmistakeable.' According to this view, distance is more firmly associated with the retinal magnitude than with the other circumstances of optical inclination. When we view an object receding, as a carriage, we are impressed with the change of distance more through the diminishing size of the picture it makes on the retina than through the approach of the optic axes to parallelism. I am not at all surprised at this, seeing that the change in the size of the retinal picture is so much more evident and distinct, as a sensation, than the very slight corresponding alteration in the inclination of the axes. When we once ascertain the real magnitude of a body, the approach or receding of it is very easily measured from this change of the picture. Now, according to Mr. Wheatstone, *the inclination of the axes, in company with a given retinal picture, suggests the mag-*

*nitude first, and from the true magnitude thus known and the retinal magnitude we infer the distance.**

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* When a known object is magnified by a lens we suppose it brought nearer to us, owing to this increase of retinal magnitude while the convergence remains the same.

I have not adverted in the text to the signs of distance furnished by the colour and appearance of objects. This point has been well illustrated by Dr. Reid.—*Inquiry*, Chap. vi. Sect. 22. I quote the following paragraphs:—

'The colours of objects, according as they are more distant, become more faint and languid, and are tinged more with the azure of the intervening atmosphere; to this we may add, that their minute parts become more indistinct, and their outline less accurately defined. It is by these means chiefly, that painters can represent objects at very different distances, upon the same canvass. And the diminution of the magnitude of an object would not have the effect of making it appear to be at a great distance, without this degradation of colour, and indistinctness of the outline and of the minute parts. If a painter should make a human figure ten times less than other human figures that are in the same piece, having the colours as bright and the outline and minute parts as accurately defined, it would not have the appearance of a man at a great distance, but of a pigmy or Lilliputian.

'When an object has a known variety of colours, its distance is more clearly indicated by the gradual dilution of the colours into one another, than when it is of one uniform colour. In the steeple which stands before me at a small distance, the joinings of the stones are clearly perceptible; the grey colour of the stone, and the white cement are distinctly limited; when I see it at a greater distance, the joinings of the stones are less distinct, and the colour of the stone and of the cement begin to dilute into one another: at a distance still greater, the joinings disappear altogether, and the variety of colour vanishes.

'In an apple tree which stands at the distance of about twelve feet, covered with flowers, I can perceive the figure and the colour of the leaves and petals; pieces of branches, some larger, others smaller, peeping through the intervals of the leaves—some of them enlightened by the sun's rays, others shaded; and some openings of the sky are perceived through the whole. When I gradually remove from this tree, the appearance, even as to colour, changes every minute. First, the smaller parts, then the larger, are gradually confounded and mixed. The colours of leaves, petals, branches and sky are gradually diluted into each other, and the colour of the whole becomes more and more uniform. This change of appearance, corresponding to the several distances, marks the distance more exactly than if the whole object had been one of colour.

'Dr. Smith in his 'Optics' gives us a very curious observation made by Bishop Berkeley in his travels through Italy and Sicily. He observed, that in those countries cities and palaces seen at a great distance appeared nearer

41. Passing now to the perception of *solidity*, or solid effect, on which the discovery of the stereoscope has cast a new light, by connecting it with the action of the two eyes, I find that Mr. Wheatstone, in his published paper, considers this as

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to him by several miles than they really were; and he very judiciously imputed it to this cause. That the purity of the Italian and Sicilian air gave to very distant objects that degree of brightness and distinctness which, in the grosser air of his own country, was to be seen only in those that are near. The purity of the Italian air hath been assigned as the reason why the Italian painters commonly gave a more lively colour to the sky than the Flemish. Ought they not, for the same reason, to give less degradation to the colours, and less indistinctness of the minute parts, in the representation of very distant objects?

'It is very certain that, as in air uncommonly pure, we are apt to think visible objects nearer and less than they really are, so, in air uncommonly foggy, we are apt to think them more distant and larger than the truth. Walking by the sea-side in a thick fog, I see an object which seems to me to be a man on horseback, and at the distance of about half a mile. My companion who has better eyes, or is more accustomed to see such objects in such circumstances, assures me that it is a sea-gull, and not a man on horseback. Upon a second view, I immediately assent to his opinion, and now it appears to me to be a sea-gull, and at the distance only of seventy or eighty yards. The mistake made on this occasion, and the correction of it, are both so sudden, that we are at a loss whether to call them by the name of *judgment*, or by that of *simple perception*.

'It is not worth while to dispute about names, but it is evident that my belief, both first and last, was produced rather by signs than by arguments, and that the mind proceeded to the conclusion in both cases by habit, and not by ratiocination. And the process of the mind seems to have been this—First, not knowing, or not minding the effect of a foggy air on the visible appearance of objects, the object seems to me to have that degradation of colour, and that indistinctness of the outline, which objects have at the distance of half a mile; therefore, from the visible appearance as a sign, I immediately proceed to the belief that the object is half a mile distant. Then, this distance together with the visible magnitude, signify to me the real magnitude, which, supposing the distance to be half a mile, must be equal to that of the man on horseback. Thus the deception is brought about. But when I am assured that it is a sea-gull, the real magnitude of a sea-gull, together with the magnitude presented to the eye, immediately suggest the distance, which in this case, cannot be above seventy or eighty yards; the indistinctness of the figure likewise suggests the fogginess of the air as its cause; and now the whole chain of signs, and things signified, seems stronger and better connected than it was before; the half mile vanishes to eighty yards; the man on horseback dwindles to a sea-gull; I get a new perception, and wonder how I got the still imperfectly explained. I have reason to believe, however, that having made many experiments with the view of elucidating the point, he now inclines to the view that there is a mental effect produced over and above the optical effect, which mental suggestion overrides the optical impression, and gives a perception really different from the literal sensation. The sense of solid effect, arising from the conjoined action of two dissimilar views of an object presented to the two eyes, means a suggestion to the mind that one part of the object is farther off than another, as estimated by our locomotive organs; in

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former, or what is become of it; for it is now so entirely gone, that I cannot recover it.

'It ought to be observed that, in order to produce such deceptions from the clearness or fogginess of the air, it must be uncommonly clear or uncommonly foggy; for we learn from experience, to make allowance for that variety of constitutions of the air which we have been accustomed to observe, and of which we are aware. Bishop Berkeley therefore committed a mistake, when he attributed the large appearance of the horizontal moon to the faintness of her light, occasioned by its passing through a larger tract of atmosphere: for we are so much accustomed to see the moon in all degrees of faintness and brightness, from the greatest to the least, that we learn to make allowance for it; and do not imagine her magnitude increased by the faintness of her appearance. Besides, it is certain that the horizontal moon seen through a tube which cuts off the view of the interjacent ground, and of all terrestrial objects, loses all that unusual appearance of magnitude.

'We frequently perceive the distance of objects, by means of intervening or contiguous objects, whose distance or magnitude is likewise known. When I perceive certain fields or tracts of ground to lie between me and an object, it is evident that these may become signs of its distance. And although we have no information of the dimensions of such fields or tracts, yet their similitude to others which we know suggests their dimensions.

'We are as much accustomed to measure with our eye the ground which we travel, and to compare the judgment of distances formed by sight, with our experience or information, that we learn by degrees, in this way, to form a more accurate judgment of the distance of terrestrial objects, than we could do by any of the means before mentioned. An object placed on the top of a high building, appears much less than when placed upon the ground, at the same distance. When it stands upon the ground, the intervening tract of ground serves as a sign of its distance: and the distance together with the visible magnitude, serves as a sign of its real magnitude. But when the object is placed on high, this sign of its distance is taken away, the remaining signs lead us to place it at a less distance; and this less distance, together with the visible magnitude, becomes a sign of a less real magnitude.'

other words, the impression revives to us an idea of movement to or from the eye in company with the picture. When the two eyes view the perspective of a street, there is brought up the idea of a certain amount of walking exertion, or other locomotive measurement, as part of the perception thence arising. The two eyes looking at a footstool bring up in like manner ideas of greater or less remoteness of the parts. Now the difficulty lies in explaining 'why two dissimilar pictures projected on the two retinæ, give rise to the perception of an object in relief.' 'It may be supposed,' says Mr. Wheatstone, 'that we see but one point of a field of view at the same instant, the one, namely, to which the optic axes are directed, while all other points are seen so indistinctly that the mind does not recognise them to be either single or double, and that the figure is appreciated by directing the point of convergence of the optic axes successively to a sufficient number of its points to enable us to judge accurately of its form.' But observation does not confirm this supposed indistinctness of those parts for which the eyes are not adjusted; on looking at a stereoscopic view, for example, we find that we obtain a clear and distinct picture of the whole, even when the eyes are steadily fixed upon one point, during which act, by the supposition, all points nearer or farther ought to be confusedly and imperfectly perceived. Hence it is that Mr. Wheatstone has been led to adopt the above-mentioned view of a mental suggestion coming in to present a clear and perfectly formed idea, notwithstanding the optical fact that, for many parts of the view, there actually falls upon the eyes what would be a double and indistinct image. The mind being once accustomed to fully formed views of all kinds, these are revived by the force of association, the main circumstance for determining the view being present, namely the double aspect which our experience has always connected with a solid effect, or an effect where varying distance is conjoined with lateral extension.*

* The subject of Binocular vision has been greatly studied in Germany, and there are at present two very different views as to the manner of obtaining a single perception by means of the two dissimilar pictures. Volkmann is of

42. Into this matter, however, I do not enter farther than to remark, that the same circumstances that enable us to appreciate the distances of different objects, enable us also to

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opinion that the unity is arrived at, by the mind disregarding the conflicting parts of the two pictures, and attending only to their points of agreement. To him the disimilarity is an incumbrance to be shaken off, an obstacle to be surmounted. Wundt, on the other hand, holds that the dissimilarity, far from being an obstruction, is the very instrument or medium of our motion of solidity. It is the most suggestive of all the optical marks of a third dimension. The more pronounced the dissimilarity, the more emphatic is our sense of solidity and varying distance from the eye.

In the remarks on Double Vision under the Sense of Sight, I have proceeded upon this latter view as best supported by evidence. In the theory of Volkmann there appears a needless anxiety on the subject of the double picture, as if it would necessarily distract us with two differing representations of one object. It is fancied that each eye sees a complete image in itself, and that the mind must reconcile these two separate images, before attaining the desired unity of perception. But there seems a misapprehension in so regarding the question. Each eye does not see the complete picture, but only a part of the picture; the other eye seeing the other part. We might have a body so placed to the two eyes, that the one eye should see one side and the other eye the other side; in which case, the double impression is obviously the picture. Experience tells us that an occasion like this, where both eyes must concur to give the whole extent of the picture, or where we see more by the two than by the one, involves a retreating object, or the solid effect. It is no more necessary that the two eyes should give two complete and separate pictures to the mind, than that the two hands embracing the same ball should suggest two balls; or that the thumb and finger grasping a pen should suggest two pens. The eyes are formed to aid and supplement, and not to contradict, each other. In great distances, each eye is sufficient for taking in the view; no addition is made by their conjoint action. This circumstance is to us simply a token of a far prospect. The opposite case where the two pictures has nothing in common is interpreted as the extreme of nearness in the object.

It is in all probability the fact, that one eye takes the lead in vision, the other merely coming in to supply the additions that constitute solid effect; just as in feeling any thing, we use chiefly the right hand (or the left), and attend to its indications, while the other merely corrects or adds to the notion. Our visual ideas would thus be embodied in the sensation of one eye, while the other, making no claim to have its sensation embodied separately, gives that extension of view and those adjuncts that serve in the full solid effect. Dr. Carpenter has made this remark, with reference to the binocular microscope. The observer uses one eye principally, and for that eye, it is desirable that the instrument should be as perfect as possible; the other eye has no farther use than to bring out the stereoscopic picture.

appreciate solid effect, or the continuity of an object through varying distances. The change in the inclination of the axes and the retinal picture together, in proper portions, suggests the width of a street to be the same all through, and this being the case, the diminished picture tells us of the remoteness of the different parts in succession. So with any other object extended in three dimensions.

A question has been raised as to our mode of perceiving the direction of an object from the eye. On this I would still repeat that direction is not a perception of sight alone; its very meaning precludes the supposition. It implies the locomotive or other movement that would lead us up to the object, or produce a definite change in its appearance. But there is a certain optical effect constantly associated with the sense of direction, as there is with the sense of magnitude or of distance, and this effect it is interesting as a matter of fact to ascertain. Now it appears most probable that the line of visible direction is a line passing from the place of an object's impression on the retina through the centre of the crystalline lens:* hence we associate an effect on the centre of the retina with a direction on the line of the axis of the eye, while an impression to the right of this point would suggest a position left of the axis. But without the experience of our moving organs generally, we should never know either the meaning of direction or the fact that a certain impression of the retina implied a certain course for us to take in reference to the object. If the optical law had been entirely different, if, for example, an object were to lie in a direction inclined 45° to the plane of its image in the retina, we should equally well become acquainted with direction; experience would connect the locomotive estimate with the visual impression exactly as is done now. The question is very much of the same nature as that of inverted vision, formerly discussed; it matters not where

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* This line has been variously stated. Sir David Brewster affirms that it passes through the centre of the eye. See p. 216 of a work entitled, *Essai sur les Phosphènes, &c., par le* Dr. Serre, Paris, 1853.

or how the optical effect takes place, association connects the true perception with it. In fact, when we dress by a mirror we perform a series of inversions, very difficult at first, but in the end as easy as it is to work under direct vision.

43. *Localization of Bodily Feelings.*—The localization of our bodily feelings presents an interesting case of acquired perception. Previous to experience, we have no notion of the seat of any local sensation, as, for example, a pain in the shoulder, or the toe. It is impossible we should have such a notion instinctively, the very nature of the case forbids it, seeing that we must connect an internal feeling with a picture to the eye, or an estimate to the touch, of the part where the feeling arises.

Our own body is a thing exposed to all our senses and to the sweep of our movements like a table, or a statue, or a fowling piece. The eye can scan nearly the whole of it; the hand can sweep over it; the legs can move over parts of it; the ear can hear the sounds it makes; the mouth and tongue can co-operate with the hand. The eyes can appreciate the colour, outline, and solidity; the vision, accustomed to the perception of size and distance, can form an estimate of the remoteness of the parts and the magnitude of the whole; the body's own various movements concurring in the estimate.

So far the body is to us an external object; but it is also the seat of sensibility of various kinds, which sensibility we can usually refer to some locality at the head, arms, chest, &c. The question arises, how do we come to have this knowledge of locality? I answer, by experience and association, based on the distinctness of the nerve fibres supplied to the different parts. (See Touch, p. 191.) A pinch in the toe is not sensibly different in quality from a pinch in the finger; but if both were happening together, we should have a sensation of two actions, and not of a single action made stronger. This is owing to the distinctness of the nerves, which keep their currents apart up to the cerebral centre; and through this distinctness we can form separate associations with each. I can associate one pain with the sight of my finger, another pain with the sight of my toe, and a third with the position of my arm, that determines the crown of the head. An infant at the outset knows not where to look for the cause of an irritation when anything touches it; by and by the child observes a coincidence between a feeling and a pressure operating on some one part; whence a feeling in the hand is associated with the sight of the hand, and so for other members.

When the feeling is more internal, as in the interior of the trunk, we have greater difficulty in tracing the precise seat; often we are quite at a loss on the point. In such a case we have to trust to some indications that come to the surface, or to the effect of superficial pressure on the deep parts. By a hurt on the ribs we come to connect feelings in the chest with the place on our map of the body; we can thus make experiments on the deep-seated organs, and learn the meaning of their indications. But the more inaccessible the parts, the more uncertainty is there in assigning the locality of their sensations; if, in addition, they are not well supplied with distinctive nerves, the difficulty is still greater. The liver, the spleen, and the kidneys, are, I believe, all indistinct as regards the feelings connected with them. In those places on the skin where the sentient units of nerve are wide apart, as in the back, the calf of the leg, &c., we can never acquire a minute appreciation of locality; the limit of distinctness of the nerve fibres will be the limit of the acquired perception.

This association between an internal feeling and the sight or touch of the place where it originates, acts reciprocally, and produces singular effects. Fixing the eye on a part of the body, as the hand, and intently regarding it for some time, we can actually generate a sensation in the skin, by a sort of back current; the *idea*, which I conceive to be a past experience revived on the same nervous tracks, has a tendency to induce the *reality*. In the artificial sleep known as the mesmeric state, this influence has been carried to great lengths. Mr. Braid has employed it to induce healthy actions upon diseased organs, being able also to cause the opposite effect of inducing unhealthy changes.

44. *Associated differences in Sensations.*—We have seen that discrimination is a fundamental property of the intellect, and that in so far as we can note differences in our sensations, to that extent these may be called intellectual. Even in Feeling, the nice discrimination of more or less, or of one kind as compared with another kind, is an intellectual act. If one person is sensitive to a small difference in pleasurable or painful sensibility, that would be unfelt by another person, the one may be said to be superior to the other intellectually. Discrimination is the groundwork of all knowledge ; for to know things is to be impressed with their respective *characteristic* sensations or impressions. We should not know any human beings if they all impressed us alike. A botanist sees in a meadow twenty species of grasses ; an ordinary person has perhaps remarked three or four. As discrimination extends, knowledge and all its valuable consequences extend also.

There is an important class of sensations that in themselves, or as originally felt, are precisely identical, but, by taking in different associations, become as distinct to the mind as sweet and sour in taste, acute and grave in sound, or red and green in colour. In the sense of Touch, for example, consider the two hands. If we compare the feeling of touch in the right hand with the same kind of contact in the left, we find that they are as feelings absolutely identical. But for intellectual purposes, they become quite distinct ; they can sustain totally different associations. With a touch upon my left hand, I associate a whole field of imagery seen on my left side, and with a touch on my right hand, I associate another set of imagery in connexion with my right side. If any one pinch my right hand, I incline my head and direct my eyes to the right ; if my left hand is pinched in precisely the same manner, my movements are all towards the left. The feelings seem identical in everything but association. This possibility of suspending different associations proves that there is a real difference in the sensations, that they are not confounded in the brain, though we may not trace this difference in the immediate consciousness. Association alone brings it out.*

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* Our power of localizing our feelings of Touch and Sight has been explained differently. It is maintained in Germany by Lotze, Wundt, and others, upon the evidence of experiments, that the tactile sensations of the two hands, and of the skin everywhere, are *qualitatively* different, and that this difference of quality enables us to discriminate the several localities where contacts are made. If this difference could be established, as sufficient to prevent us confounding any two adjoining spots, there would be no need for the assumption in the text, that sensations the same in quality can yet be recognized as distinct, and be made the starting point of separate associations. To obviate the objection, from our not habitually recognizing any qualitative distinction in the touches in different parts of the body, it is remarked, no doubt with justice, that we are so much concerned habitually with the objective perceptions, as not to attend to the subjective differences. These differences may, nevertheless, at an early stage, have been sufficiently marked to form the basis of our local discriminations.

In the case of Touch, the supporters of this doctrine find some difficulty in stating what is the kind of quality whose variation is perceptible over the body generally. But in Sight, there is no such difficulty. It is laid down, on the faith of observation, that the sensibility of the eye is locally different to colour; for if we cause the same colour to pass from the yellow spot to the distant parts of the retina, it will appear, not the same, but different; and the variation of shade would thus be a mark of the place in the retina where the impression falls. We have here something definite to proceed upon. We can institute an inquiry, as to whether the discrimination of difference of shades of colour is sufficiently delicate, to correspond with the minuteness of vision formerly described.

Some difficulty might be experienced, under such an hypothesis, in explaining how we should distinguish between an actual *succession* of colours and the *same* colour passing over different nerves. I do not say that this is an insuperable obstacle, if it could be shown, that our ability to distinguish nice gradations of colour is such as to approach the observed limits of fineness of vision. Between the centre of the yellow spot, and a point in the retina, say 10° removed from it, we should require to interpolate, at the very least, several hundreds of shades of redness passing into green or blue. I am not prepared to affirm that this is impossible to the primitive eye; but it is hardly consistent with our ordinary estimate of the powers of the eye, even in persons educated to the discrimination of colours. Still, the hypothesis is one that deserves to be entertained; it is in some respects, perhaps, less difficult than the assumption of a sense of difference in feelings qualitatively identical, an assumption supported only by its being adequate to account for the facts of local discrimination.

The supposition of latent qualitative differences, where to the common apprehension there is nothing but sameness, must, it would seem, be likewise

The very same line of illustration can be followed with the muscular feelings. The feeling of a stretched muscle has a uniform character all over the body, the degree of tension being made equal, and allowing for differences in the size of muscles, and, perhaps also, in their degree of intimacy with the brain. Not to insist on the case of the two arms, or the two legs, or the rotation of the body in opposite ways, which would be similar to the foregoing illustration from touch, I can suppose a weight borne by the arm to give the same amount of muscular feeling as a pressure exerted by the foot. Under this supposition two feelings are produced that have no difference, either as regards feeling, or as stimulating volition; yet experience shows that they are recognised as distinct by the mind. The two muscular tensions are made manifest to the consciousness by different nerves, and, on this fact the mind is able to build and maintain distinct associations, although not aware of any difference, either of quantity or quality, in the feelings as such. We have already called attention to the articulate character of the sense of Touch, arising from the independence of the nerves of the skin, as distributed over the general surface,—a remark applicable also to the nerves supplied to the different muscles. The same kind of feeling, coming from different parts, is recognised as different by taking on different associations, Before any associations are formed, the difference is latent; after the growth of distinctive connexions, it is unmistakeable. It is shown that the localising of our feelings—the possibility of assigning a locality to each—is founded on this distinct-

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extended to the muscles. It would have to be shown that there is something distinct in the muscular feelings of the two arms exerted exactly in the same way. When muscles are of very different magnitude and calibre, as the deltoid of the shoulder, the biceps of the arm, the diaphragm, and the orbicular muscle of the mouth, I can readily suppose that we should be differently affected by their contraction; the difficulty consists in assigning a characteristic peculiarity in the feeling of expended energy in two muscles in all respects resembling, as in those of the two sides of the body, and in others almost identical in size and in form.

ness of the nerves arising from different parts. If a prick in the leg and a prick in the arm were as undistinguishable in every way, as they are to the mere sense of pain, we should never be able to connect the one with our notion of the leg, and the other with our notion of the arm, or with any of the other discriminating features of those two members.

If not superfluous, after these examples, the eye might be adduced to the same effect. The place of the retina, impinged upon by a ray of light, is, in the main, unimportant as respects the feeling of light, but there is, notwithstanding, a real difference in the intellectual point of view, brought out, as in the other cases, by association. We can thus discriminate right and left, up and down, centre and circumference, in our field of view, as soon as any characteristic actions, or consequences, become connected with the different portions of the retina impinged upon from these various outward positions of the rays of light. The retina is in this respect, identical with the skin; it consists of a number of independent nerve fibres, each transmitting the same quality of impression, but to a distinct region of the common centre of visual impressions, and so as to form the starting point of a perfectly distinct series of accompanying impressions. A man at a telegraphic station, under the old system of signals, saw the same arm repeated to his view, but with its picture on the lower part of the retina he connects one action, on the upper part another action. This is associated discrimination.*

ASSOCIATES WITH FEELING.

46. The element of Feeling, or pleasure and pain, viewed as such, enters into alliance with the more intellectual ele-

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* *Sir William Hamilton's theory of the inverse relation between Sensation and Perception.* This theory has been stated by its author as follows—'*Though a perception be only possible under condition of a sensation; still, that above a certain limit the more intense the sensation or subjective consciousness, the more indistinct the perception or objective consciousness.*' By the 'sensation' is here meant the feeling as regards pleasure or pain; by the 'perception' I understand what is termed above the intellectual discrimination; the difference is like that between the excitement of a blaze of sunshine and the discrimina-

ments of the mind, as, for example, those perceptions of outward things that we have just been considering. This alli-

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tion of two natural history specimens. These two effects Sir William Hamilton believes to be inverse to one another; that is, in proportion as the one is strong the other is weak. I am disposed to admit the truth of this doctrine to a very considerable extent. But it appears to me that the facts as to the relation of these two qualities,—the emotional on the one hand, and the intellectual on the other—show a greater degree of complexity than this law expresses, even although it be correct as to the prevailing character of the relation.

The following extract contains the statement of the facts adduced in support of this theory by its author. 'If we take a survey of the senses, we shall find, that exactly in proportion as each affords an idiopathic sensation more or less capable of being carried to an extreme either of pleasure or pain, does it afford, but in an inverse ratio, the condition of an objective perception more or less distinct. In the senses of Sight and Hearing, as contrasted with those of Taste and Smell, the counter proportions are precise and manifest, and precisely as in animals these senses gain in their objective character as means of knowledge, do they lose in their subjective character as sources of pleasurable or painful sensations. To a dog, for instance, in whom the sense of smell is so acute, all odours seem, in themselves, to be indifferent. In Touch or Feeling the same analogy holds good, and within itself; for in this case, where the sense is diffused throughout the body, the subjective and objective vary in their proportions at different parts. The parts most subjectively sensible, those chiefly susceptible of pain and pleasure, furnish precisely the obtusest organs of touch; and the acutest organs of touch do not possess, if ever even that, more than average amount of subjective sensibility. —The experiments of Weber have shown, how differently in degree different parts of the skin possess the power of touch proper; this power, as measured by the smallness of the interval at which the blunted points of a pair of compasses, brought into contact with the skin, can be discriminated as double, varying from the twentieth of an English inch at the tip of the tongue, and a tenth on the volar surface of the third finger, to two inches and a half over the greater part of the neck, back, arms, and thighs. If these experiments be repeated with a pair of compasses not very obtuse, and capable, therefore by a slight pressure, of exciting a sensation in the skin, it will be found, that whilst Weber's observations, as to the remarkable difference of the different parts in the power of tactile discrimination, are correct; and that, at the same time, what he did not observe, there is no corresponding difference between the parts in their sensibility to superficial pricking, scratching, &c. On the contrary, it will be found that, in the places where, objectively, touch is most alive, subjective feeling is, in the first instance at least, in some degree deadened; and that the parts the most obtuse in discriminating the duplicity of the touching points, are by no means the least acute to the sensation excited by their pressure.

ance or association between feeling and imagery gives rise to a number of interesting phenomena, some of which may be introduced here, as presenting a new case of the associating process.

In the pleasures and pains derived through the various

' For example;—The tip of the tongue has *fifty*, the inferior surface of the third finger *twenty-five* times, the tactual discrimination of the arm. But it will be found, on trial, that the arm is more sensitive to a sharp point applied, but not strongly, to the skin, than either the tongue or the finger, and (depilated of course) at least as alive to the presence of a very light body, as a hair, a thread, a feather, drawn along the surface. In the several places the phenomena thus vary:—In those parts where touch proper prevails, a subacute point, lightly pressed upon the skin, determines a sensation of which we can hardly predicate either pain or pleasure, and nearly limited to the place on which the pressure is made,' &c.—*Edition of* REID, p. 863.

On these last experiments I would remark, first, that the tongue is scarcely a fair subject of comparison with the skin, seeing that the two tissues are not of the same nature; a matter of considerable importance as regards a pleasurable or painful irritation; and, therefore, the fairest mode of conducting the trial is skin with skin.

Secondly, if trial were made of the cheek compared with the other parts, the inverse proportion contended for would not hold good. To a prick, or a smart blow, the cheek is at least as sensitive as any portion of the skin whatever; but it is certainly not the least discriminating in Weber's scale. In fact it stands high in the scale, being equal to the palm of the hand and the extremity of the great toe, and inferior only to the tongue, lips, and fingers. In this case, therefore, the inverse ratio of sensibility and discrimination does not subsist.

Taking the cheek and the back of the hand as compared with the palm of the hand, one would be disposed to say that the sensitiveness to pain varied with the structure of the cuticle, while the discrimination depends solely on the supply of nerves. Let the cuticle be thickened as in the hand and foot; the parts are rendered obtuse to a blow. But where the cuticle is thin, the skin is correspondingly tender or susceptible to painful or pleasurably irritation. This is a popular belief, whether scientifically true or not. Any one keenly alive to a smart or an attack is said to be *thin-skinned*. In addition to this, I am disposed to believe that the parts nearest the brain are in consequence more sensitive than remote parts. The agonies of tooth-ache, face-ache, pains of the nose and ear, appear to be more intense than would arise from similar irritations in the lower extremities. If this be a general rule, the skin of the face would be more sensitive than the skin of the arm or the hand, and these more than the leg or foot.

In so far as the differences of sensibility and discrimination depend on senses and through the moving organs, associations spring up with collateral things, the causes or frequent accompaniments of those feelings. Thus we connect the pleasures of repose with an easy chair, a sofa, or a bed, and the pleasure of riding with a horse and carriage. The sight of food recalls a certain part of the pleasure of eating. The preparation of meals and the catering for the table are interesting avocations, through a reference to the end they serve. The representation to the eye of fragrant flowers in a painting, has power to revive some of the pleasures that we gain from the reality through the sense of smell. The pleasures of music, in so far as they can be enjoyed in the retrospect, are evoked purely by association.

We have seen that it is a quality of some feelings to be more recoverable in idea than others; for example, the pleasures of music and spectacle are recovered from the past more completely than the pleasures of exercise, repose, warmth, or repletion. When those higher feelings are revived, by means of association, a much greater approach is made to the intensity of the actual experience.

47. It will not be out of place to select a few examples of the association of the deeper emotions of the mind with the notions that we have of outward things, by which connexion these emotions also can be made present in the absence of their proper stimulus. The emotions of Tenderness, Self-com-

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the *mind*, Sir W. Hamilton's theory of inverse relation is more strictly applicable. It is to me quite evident that, if the whole mind and attention be concentrated on the sensation as a feeling, as giving pleasure or pain, there will be a lack of attention to the intellectual quality. But then it is possible that the mind should be awake to both qualities, and to the one for the sake of the other. Thus if I am exceedingly annoyed with the bitterness of a taste, I am also impressed with its character as distinguished from other bitters; the intensity of my dislike will impress upon me the discriminating character of the substance among other substances, an effect strictly intellectual.

Mr. Spencer has criticised the doctrine of Hamilton (Psychology, p. 279), and has summed up the result in the following sentence :—'Generalising the facts, then, it would seem, not so much that Sensation and Perception vary inversely, as that they exclude each other with varying degrees of stringency.'

placency, Irascibility, Terror, &c., when stimulated repeatedly in the presence of some one object, enter into mental partnership with that object, and the two individuals of the couple are thenceforth able to revive each other, the object recalling the emotion, and the emotion restoring the object.

The emotion of Natural Tenderness is brought out chiefly towards sentient beings, and comes, after a time, to flow habitually in connexion with certain persons or living creatures, who are then said to be objects of affection or attachment. The feeling, moreover, overflows upon places and things, stimulating a tender regard towards inanimate nature. The associations with home, with one's native spot, with the tokens of friendship and the relics of the departed, are made powerful by all the causes that give force to the contiguous bond. The natural abundance of the emotion in the character, repetition, a good natural adhesiveness, the disposition to cultivate this peculiar region of associations—all contribute to strengthen the link that enables persons or things to diffuse tender feeling over the mind. We may suppose some mental constitutions to have a natural retentiveness for special emotions, just as there are intellects retentive of visible pictures, music, or language; this retentiveness not being identical with the strength of the emotion in the reality. Such persons would be peculiarly qualified to cultivate associated feeling, to derive pleasure from the relics and the memory of affection, and to make this pleasure an object of pursuit in life.

The illustration for objects of hatred and aversion, and for all the outgoings of the Irascible passion, would be almost parallel to the above. This passion connects itself with persons, with places, things, events, &c., and may be revived by objects that of themselves have no natural power to stir it up. We are apt to feel an aversion to places where we have suffered deep injuries, and to the unwitting instruments of calamity and wrong. There is a certain moral effort sometimes needed, to prevent the passion of hatred from spreading too widely over collateral and indifferent things. Minds, at once irascible and weak, have generally an excessive amount of associated dislikes.

Egotistic and Selfish emotion diffuses itself over all matters related to self; and the objects that a man surrounds himself with, come to reflect the sense of his dignity and importance. According as this feeling is indulged, associations grow up between it and a great variety of things, Possessions, office, the fruits of one's labour, the symbols of rank, are all overgrown with this connexion, and radiate the feelings of self-complacency and importance to the mind. The members of one's family are objects not simply of tender affection, but of affection and egotism combined. So with friends, and with all the objects of our habitual admiration. It is impossible to be in the constant practice of loving or admiring anything, without coming at last to connect the object with self; the disinterested regard that first attracts us to persons, becomes, by indulgence, interested affection.

48. The pleasure of *money* is a remarkable instance of associated feeling. The sum total of purchasable enjoyments becomes linked in the mind with the universal medium of purchase, and this medium grows into an end of pursuit. In the first instance, we are stimulated by these other pleasures, but an affection is often generated at last for money itself. This transfer is brought about when we allow ourselves to be so engrossed with the *pursuit* of wealth, that we rarely advert to the remote ends or the purchasable pleasures; the mind dwelling solely on the one object that measures the success of our endeavours. A moderate pursuit of gain that leaves the mind free to dwell upon the pleasures and advantages that money is to bring, does not generate that intense affection for gold as an end which constitutes the extreme form of sordid avarice.

Another example of an association, displacing the original source and purpose of a feeling, is seen in connection with the *forms* of business. Book-keeping, legal formalities, and technical procedure, are intended as aids to the transaction of business. In themselves nothing, they have a great value in furthering our substantial ends, and we contract a sentiment towards them on that ground. As with money, however, this reflected interest sometimes detaches itself from the original ends; and we find a pleasure in maintaing formalities that time and change have reduced to an empty letter.

49. *Alisonian Theory of Beauty.*—This celebrated doctrine precisely exemplifies the case of contiguous association now in hand, in so far as we are disposed to admit the applications that its author makes of it. That he has carried his theory of associated pleasure too far might, I think, be shown in numerous instances. We have already seen that all the senses yield us sensations that are in themselves pleasurable, without reference to any associated effect. There are fragrant odours, sweet sounds, and pleasing effects of light and colour, in which the pleasure is owing to a direct and immediate action of the objects upon the organs of sense, and these pleasurable feelings never fail to be produced when we are in a condition to enjoy them. There would be nothing permanently or generally pleasing, if we had not a certain number of such primary sources of enjoyment.

The doctrine of Alison satisfactorily explains the strong effects often produced on our minds by sensations and objects, in themselves indifferent, or wholly unequal to those effects. A few instances of this nature may be quoted as true examples of borrowed or associated emotion. To take the case of sounds: 'All sounds,' says Mr. Alison, 'are in general SUBLIME, which are associated with ideas of great Power or Might; the Noise of a Torrent; the Fall of a Cataract; the Uproar of a Tempest; the Explosion of Gunpowder; the Dashing of the Waves, &c.' Most of these sounds, however, are intrinsically impressive from their intensity and volume, and the effect that they have on the mind is not wholly due to association. The following is a better selection for the purpose in hand. 'That the Notes or Cries of some Animals, are Sublime, every one knows; the Roar of the Lion, the Growling of Bears, the Howling of Wolves, the Scream of the Eagle, &c. In all these cases, those are the notes of animals remarkable for their strength, and formidable from their ferocity.' In like manner, the author exemplifies associations with the feeling of Beauty, as follows:—'The Bleating of a Lamb is beautiful in a fine day in spring; the Lowing of a Cow at a distance, amid the scenery of a pastoral landscape in summer. The call of a Goat among rocks is strikingly beautiful, as expressing wildness and independence. The Hum of the Beetle is beautiful on a fine summer evening, as appearing to suit the stillnesss and repose of that pleasing season. The Twitter of the Swallow is beautiful in the morning, and seems to be expressive of the cheerfulness of that time. A similar illustration can be derived from Colours and appearances to the eye. The impressive emotion roused by the discharge of thunder can be evoked by the transient flash in the window, an effect in itself very trivial, but able to recall the grander features of the phenomenon, and through these the emotion of the Sublime. The relics of a storm, seen in the disorder and wreck, revive the feeling impressed by the height of its fury. The language that describes such phenomena, when aptly used, can arouse the emotions purely by the force of association.

Alison extends the illustration of his doctrine to Forms and Motions as well as sounds and colours, and supplies examples in great abundance under all these heads. I believe he has here too in many instances put forward intrinsic effects as the effects of association, but, nevertheless, he has put it beyond dispute, that the associating principle operates largely in clothing *indifferent* objects with a power to raise emotion in the mind of the beholder.

There is, I am satisfied, a *primitive* influence in Form to produce a certain amount of emotion, of the kind that enters into the compositions of Art. Curved forms and winding movements yield, of themselves, a certain satisfaction through the muscular sensibility of the eye. Yet we must add to this original impressiveness an influence of association; namely, the connexion of Ease and abandon with the curving line, and of Constraint with the straight line. The free movements of the arm make circular figures; to draw a straight line requires a painful effort.

In everything of the nature of a Tool or a Machine, there are certain appearances that are pleasing to behold, as suggesting Fitness and Ease in their application to the end. A clear polish upon steel has this effect, while rust is painful from the suggestion of a harsh grating action. So the absence of noise, in the working of a machine, gives us the agreeable feeling of smooth, easy action.

Before passing from this subject, I may remark that there is a certain *refining* effect frequently produced by keeping the original cause of a feeling at a distance, and viewing it thus through a medium. Thus the sensation of healthy functions is one of our principal enjoyments; the hue and fulness that are the outward aspect of health, are pleasurable by association, and according to Alison are beautiful; the one degree of remove from direct consciousness, converts a sensual pleasure into a sentimental one. Waving corn-fields, heavy and ripe, are agreeable objects by association with the supply of our bodily wants, and the delight is refined upon by keeping at some distance the actual and ultimate sensations that give all the force to the appearance. A feeling that, in the reality, would be called by comparison gross and sensual, becomes sentimental when the mind has some intervening object to rest upon.

50. *The Reading of Emotional Expression.*—An interesting case of associated feeling is our being able to interpret the signs of feeling in our fellow-beings, by which we are not merely made aware of their state of mind, but also derive a large amount of pleasurable and painful feeling in ourselves. The influence of the smile or the frown, so powerfnl in human life, is purely an associated influence. There is nothing intrinsic in the lines and forms of feature, displayed in the act of smiling, to cause the pleasure occasioned by this manifestation. Incidentally, fine forms and curves may be produced in a face, and there may be a display of beautiful tints over and above, but when these things occur they constitute

additional pleasure, they do not originate the pleasing effect of the act itself.

The meaning of a smile, together with the susceptibility to the cheering influence of it, are learnt among the early acquisitions of infancy. The child observes that this expression accompanies the substantial pleasures that need no association to give them their character. The smile of the parent, or of the nurse, means all the agreeables of food, dress, play, spectacle, excitement, society. The frown is as invariably connected with privation and pains. An enduring association thus obtains between one cast of features and all the good things of life, and between another expression and the ills that human power can inflict; and hence the one is able to diffuse a gladdening influence, while the other tends to excite a feeling of depression and gloom. All through life we are subject to these influences of associated emotion. So, there are tones of voice that, in the same way, can cause pleasure or pain by a power of suggestion. In this case, however, there is a certain intrinsic efficacy in the tones usually adopted to convey the intended effect. For conveying love and approbation, we choose our soft and gentle tones; for the opposite, we are led, both by passion and by choice, to use tones that are painful and grating. I cannot discern any original or intrinsic difference of effect between pleased and angry features, but, in vocal utterance, there is a manifest suitability of some tones for pleasing expression, and of others or the reverse.

It is a part of our pleasures to see happy beings around us, and especially those that have the power of expressing their feelings in a lively manner. Children and animals, in their happy moods, impart a certain tone of gaiety to a spectator. On the other hand, the wretched, the downcast, and the querulous, are apt to chill and depress those in their company.

There is a satisfaction in merely beholding, or even in imagining, the appearances and accompaniments of superior happiness, which probably accounts in part for the disposition to do homage to the wealthy, the powerful, the renowned, and the successful among mankind.

Associated emotion is the medium of sympathy with the feelings of others. We have to acquire the signs of feeling, in order to make the states of others our own. We learn the natural appearances of the different emotions, and also the names that describe them, which appearances and names are the medium for realizing them. As in all else, there are great individual differences of progress in this acquirement, and corresponding differences in the power of sympathy.

Among the associations of Feeling, we should not omit the important sentiments of Moral Approbation and Moral Disapprobation. These are admitted on all hands to be greatly the result of education; indeed, the fact is too notorious to be controverted. The well-trained child constantly finds certain actions spoken of with marked approbation, and visited with pain, which gives to disapprobation its meaning; and there grows up, as a consequence, a strong association between those actions and the feelings of dread and aversion. A high motive power is thus generated for abstaining from lying, theft, cruelty, neglect of studies, and other forbidden acts. This is one side of our moral education. The other side is, in like manner, a series of associations between certain actions and praise, approval, or reward, and these determine the acquired sentiment of moral approbation. How little of either of the two modes is to be found where nothing has been done to impress them, is best known to those that concern themselves with the outcasts of society.

The rate of advancement in moral training depends on several circumstances. In the first place, the energy of the impulses that trespass against the laws of society may be strong, or they may be weak, by nature. But, secondly, a still greater importance must be attached to the aptitude for vividly retaining the penalties, and expressed disapprobation, of wrong. This memory for good and evil appears to be a special, or local, mode of retentiveness, as much so as colour or music: it does not always accompany high intellect generally, and it is occasionally strong, when the power of recollection in other things is weak. It belongs, no doubt, to the same circle of sensibilities that includes our prudential and our sympathetic regards. For both prudence and sympathy must concur to a well developed moral sense.

There are many of our strong likings on the one hand, and strong antipathies on the other, that come under the class of reflected influences. The sight of blood affects some persons to fainting, which cannot be owing to anything in the mere appearance of it; apart from association, the rich scarlet hue would make this a really agreeable object to the eye.

ASSOCIATIONS OF VOLITION.

51. I have already adverted to the mistake, committed by Reid, in pronouncing the voluntary command of our limbs and other moving organs instinctive. If we observe the movements of infancy, we see plainly that, for many months, there is no such thing as a command of the active members, in obedience to an aim or purpose present to the mind. An infant may have sufficient intelligence to form a wish, and be quite unable to execute the simplest movements for attaining the thing wished. A common example of this is the attempt to seize something with the hand, as a spoon; we see the most awkward movements occurring, evidently from the entire want of any definite direction of the limbs at that stage. This definite direction is acquired; and the acquisition is the most laborious and difficult of all human attainments. The performance of the simple movements that we wish to perform, is the basis of our acquirement of more complex movements at a subsequent stage; but our first education is self-education. Until a child can, of its own accord, put out its hand and seize an object before its eyes, which for the first few months it cannot do, any attempt to direct it is in vain; and, until, of its own accord, it can move its own body as it sees something else moved, it has not begun to be an educable being.

The voluntary command of the organs implies the following things. 1st, The power of *continuing* or *abating* a present movement in obedience to a present feeling, as when the child sucks while the appetite is gratified, and ceases when satiety comes on. We have referred this to a primary law of the animal organization, namely, that pleasures are accompanied with an increase, and pains with a diminution, of the vital energies. So far, Volition is an Instinct. 2dly, The power of *beginning* a movement in order to heighten or abate a present feeling, as when the child directs its head and mouth to seize the nipple, and begins sucking. There may be a few instances of instinctive movements of this kind, but in general they are acquired, being determined by means of association. The coincidence of the movement and the feeling must be at first accidental; the movement springing up of its own accord, and finding itself able to control the feeling, the two become after a time so firmly connected that the one suggests the other. Thus the movement of the eyes and head is at first spontaneous, but the agreeable feelings of light brought on by these movements prompt their continuance, and the pleasure gets to be associated with these movements; whereupon, when this feeling is present to the mind as a wish, it prompts the requisite exertions. Thus it is that a child learns to search out a light in a room in order to enjoy the maximum of the illumination; it learns to turn its view to the fire, or the window, or to some face that it has begun to recognise agreeably. Volition means, 3dly, the performance of some intermediate actions with a view to our gratification; as when things are seized with the hand in order to be carried to the mouth, and when animals, recognising their food at a distance, set themselves to move forward to lay hold of it. These intermediate actions are most manifestly the result of experience, in the human subject at least. The power of locomotion has first to be developed; the exerting of the power then becomes associated with its various consequences, and among others that of bringing the individual within reach of the objects of its desires. 4thly, The voluntary command of the organs means the power of Imitation, or of performing actions in consequence of seeing them performed. Here a link has to be established between a certain appearance to the eye and the movement of corresponding organs in the individual's self. In the case of vocal imitation, a sound is the antecedent of an utterance, each sound heard being associated with a distinct movement of the chest and larynx, under the proper attitudes of the mouth. It is not uncommonly supposed that imitation, both of actions and of sounds, is instinctive; but I believe this to be incorrect. 5thly, Under volition we understand the power of moving our organs merely on the wish to see them moved; as when I look at my hand, and will to raise it. Here a connection is formed between the sensible appearance of any member, or the idea left by that sensible appearance, and its being moved. Lastly, we can make a movement on being directed to do so, by the part being named; 'up head,' 'down hands,' &c. This is a further association, formed between certain names or sounds and a particular class of movements. All these various actions are employed in the most elementary efforts of the will to control the body. Others could be named that transcend their range of influence, as, for example, the control of the passions and the command of the thoughts.*

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* The following are notes of observation made upon the earliest movements of two lambs seen during the first hour after birth, and at subsequent stages of their development. The two came from the same mother, and their actions were in the main alike.

One of the lambs, on being dropped, was taken hold of by the shepherd, and laid on the ground so as to rest on its four knees. For a very short time perhaps not much above a minute, it kept still in this attitude. A certain force was doubtless exerted to enable it to retain this position; but the first decided exertion of the creature's own energy was shown in standing up on its legs, which it did after the pause of little more than a minute. The power thus put forth I can only describe as a spontaneous burst of the locomotive energy, under this condition, namely, that as all the four limbs were actuated at the same instant, the innate power must have been guided into this quadruple channel in consequence of that nervous organization that constitutes the four limbs one related group. The animal now stood on its legs, the feet being considerably apart so as to widen the base of support. The energy that raised it up continued flowing in order to maintain the standing posture, and the animal doubtless had the consciousness of such a

52. In order to illustrate the acquired character of these several voluntary actions, excepting always the first, I shall select the case of Imitation. If we can prove to satisfaction that this is not instinctive, but acquired, little doubt will remain on the other cases.

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flow of energy, as its earliest mental experience. This standing posture was continued for a minute or two in perfect stillness. Next followed the beginnings of locomotive movement. At first a limb was raised and set down again, then came a second movement that widened the animal's base without altering its position. When a more complex movement with two limbs came on, the effect seemed to be to go sideways; another complex movement led forwards; but at the outset there appeared to be nothing to decide one direction rather than another, for the earliest movements were a jumble of side, forward, and backward. Still, the alternation of limb that any consecutive advance required, seemed within the power of the creature during the first ten minutes of life. Sensation as yet could be of very little avail, and it was evident that action took the start in the animal's history. The eyes were wide open, and light must needs have entered to stimulate the brain. The contact with the solid earth and the feelings of weight and movement were the earliest feelings. In this state of uncertain wandering with little change of place, the lamb was seized hold of and carried up to the side of the mother. This made no difference till its nose was brought into contact with the woolly skin of the dam, which originated a new sensation. Then came a conjunction manifestly of the volitional kind. There was clearly a tendency to sustain this contact, to keep the nose rubbing upon the side and belly of the ewe. Finding a certain movement to have this effect, that movement was sustained; exemplifying what I consider the primitive or fundamental fact of volition. Losing the contact, there was as yet no power to recover it by a direct action, for the indications of sight at this stage had no meaning. The animal's spontaneous irregular movements were continued; for a time they were quite fruitless, until a chance contact came about again, and this contact could evidently sustain the posture or movement that was causing it. The whole of the first hour was spent in these various movements about the mother, there being in that short time an evident increase of facility, in the various acts of locomotion, and in commanding the head in such a way as to keep up the agreeable touch. A second hour was spent much in the same manner; and in the course of the third hour, the animal, which had been entirely left to itself, came upon the teat, and got this into its mouth. The spontaneous workings of the mouth now yielded a new sensation, whereby they were animated and sustained, and unexpectedly the creature found itself in the possession of a new pleasure; the satisfaction first of mouthing the object—next, by-and-bye, the pleasure of drawing milk; the

The imitations practised in early life are, first, the vocal, led by the ear,—speech, song, and cadence; secondly, the external organs led by the eye,—the hands, feet, trunk, head and mouth; and thirdly, the features, which we are longer in acquiring a command over. I speak not at present either of the complex case of dramatic imitation and mimicry, or of the sympathies with emotion, as in laughter, tears, &c.

(1.) The first argument against instinctive imitation is the fact, that no imitation whatever takes place during the first few months of infant existence. So far as my observation goes, there is very little during the first year. But a primitive

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intensity of this last feeling would doubtless give an intense spur to the co-existing movements, and keep them energetically at work. A new and grand impression was thus produced, remaining after the fact, and stimulating exertion and pursuit in order to recover it.

Six or seven hours after birth the animal had made notable progress. Locomotion was easy, the forward movement being preferred, but not predominant. The sensations of sight began to have a meaning. In less than twenty-four hours, the animal could, at the sight of the mother ahead, move in the forward direction at once to come up to her, showing that a particular visible image had now been associated with a definite movement; the absence of any such association being most manifest in the early movements of life. It could proceed at once to the teat and suck, guided only by its desire and the sight of the object. It was now in the full exercise of the locomotive faculty; and very soon we could see it moving, with the nose along the ground in contact with the grass, the preliminary of seizing the blades in the mouth.

I am not able to specify minutely the exact periods of the various developments in the self-education of those two lambs, but the above are correct statements to the best of my recollection. The observations proved distinctly these several points, namely, first, the existence of spontaneous action as the earliest fact in the creature's history; second, the absence of any definite bent prior to experienced sensations; and third, the power of a sensation actually experienced to keep up the coinciding movement of the time, thereby constituting a voluntary act in the initial form. What was also very remarkable, was the rate of acquisition, or the rapidity with which all the associations between sensations and actions became fixed. A power that the creature did not at all possess naturally, got itself matured as an acquisition in a few hours; before the end of a week, the lamb was capable of almost anything belonging to its sphere of existence; and at the lapse of a fortnight, no difference could be seen between it and the aged members of the flock.

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impulse ought to appear much earlier. The instinctive movements discussed in the preceding Book show themselves from the very commencement of life. There is no new development or manifestation of power at the time when the imitative propensity comes on; there is nothing parallel, for example, to the physical changes that show themselves at puberty, along with the new feelings of that period. The child is seen to go through a great deal of active exertion of its own, in the course of those unimitative months; the power of repeating the actions of others would be exceedingly valuable at this time, and would save much fruitless endeavour; but the very faintest tendency in this direction cannot be discerned. There may be instances of a more precocious faculty than any that I have observed, but these would not affect in any material degree the present argument.

(2.) In the second place, imitation, when it does begin, is slow and gradual in its progress, a fact that looks like acquisition, and not like Instinct. We find, for example, that, in speech, the imitation is at first limited to one or two articulations, and that others come on by degrees at considerable intervals. If there were any primitive connexion in the brain between a sound heard, and the reproduction of that sound with the voice, it ought to be as good for one letter of the alphabet as for another. So with the movements of the hand; why should one be possible, while no amount of example will bring out a second, not in itself more difficult?

(3.) The imitation very often fails after it has once been hit. A child has caught a certain sound, and will at particular times produce it, and yet at other times there is no possibility of bringing on the utterance. This is constantly seen in the first efforts of children. It is in vain that we repeat in their ear, a sound, a letter, or a syllable that they have shown themselves able to pronounce; the association between the audible impression and the specific vocal exertion has plainly not yet been formed; it cannot therefore be instinctive. The child has, in the course of its spontaneous articulate movements, come on the sound *hum*, and this sound once pronounced is likely to recur in the cycle of its spontaneous actions, but to utter the syllable at the instance of another person's utterance is something additional. As an acquisition, I can easily render to myself an account of the process. The sound spoken is also heard; besides the vocal exertion there is a coincident impression on the ear; an association grows up between the exertion and the sensation, and after a sufficient time the one is able to recall the other. The sensation anyhow occurring brings on the exertion; and when, by some other person's repeating the syllable, the familiar sound is heard, the corresponding vocal act will follow. Experience, I think, proves that the time that elapses between the ability to utter a sound, and the readiness to utter it on its being heard, corresponds to the time requisite for an adhesion to grow up between the two heterogeneous elements, the one a spontaneous action, the other a sensation. These early sounds come out more frequently of themselves, than under the stimulus of imitation, which proves that the exertion precedes the power of imitating.

To assert that imitation is instinctive, is to maintain the existence of an infinity of pre-existing associations between sensations and actions. Every letter of the alphabet, and every word, would require to be connected by a primitive adhesion with the movements of the larynx and mouth, whereby they are uttered. Every movement of the hand would need to be associated with the visible appearances of the same movement in other human beings. We should have to affirm the manifest absurdity that associations could be formed between things yet unexperienced; between sounds, and sights, and actions, long before anything had been heard, seen, or done.

(4.) It is notorious to observation, that more is done by the nurse imitating the child, than by the child imitating the nurse. When an articulation is stumbled on, it is caught up by all around, and the child is made familiar with the sound as proceeding from other voices, in addition to its own. This would obviously promote the growth of the needful adhesive connexion.

(5.) Imitation follows the spontaneous displays of activity, and is greatest in cases where the spontaneous variety and flexibility are good. A child will learn to imitate singing according as, of its own accord, it falls into musical notes. Its own native song must come first: the goodness of that will be a condition of its acquiring the song of others. In whatever department any individual shows spontaneous and unprompted facility, in that department will the same individual be imitative or acquisitive.

(6.) Imitation progresses with the acquired habits. In learning to dance, the deficiency of the association between the pupil's movements and the sight of the master's, renders the first steps difficult to acquire. The desired movements are not naturally performed at the outset. Some movements are made; sufficient voluntary command of the limbs and body has been acquired, in other shapes, to set a-going action of some kind; but the first actions are seen to be quite wrong; there is a manifest want of coincidence which originates a new attempt, and that failing, another is made, until at last we see that the posture is hit. The grand process of trial and error brings on the first coincidence between a movement, and the appearance of that movement in another person; repetition, by constituting a cohesive link, makes the imitation at last easy. Upon this acquisition, other new acquisitions of the same kind are based, and the improvement is accelerating. Thus it is that we pass through an alphabet of imitation in all arts; the fixing of the association, in the case of the first links, is the most difficult part of the process.

(7.) It is in harmony with all that has now been advanced, that imitation depends likewise on the delicacy of the sense that perceives the effect.

This is not the place to exhaust the subject of Imitation in particular, or of the acquisitions that enter into volition in general. It is enough, for the present, to show that the associative principle is an indispensable requisite here as elsewhere. All the conditions already specified, as affecting the rate of adhesiveness in other acquirements, might be exemplified likewise in these. The great peculiarity in the case arises from the circumstances of their commencement. Being the starting point of every other branch of education, they must find their own way through struggles and accidents, trials and failures. Reposing upon the great fundamental link between consciouness and present action,—between pleasure or pain, and the activity happening at the time,—they come at last to supply definite connexions between our feelings and exertions, so as to enable us not merely to control a movement at work, but to call dormant actions into being at the instance of our reigning desire.

Of the various circumstances affecting the progress of these volitional associations, the engagement of the cerebral energy or concentrated attention is of signal consequence. This condition, necessary at any age, seems the all-important one in the early months of our existence. The moment of an acquisition seems generally to turn upon some happy concurrence of aroused attention, or mental engrossment, with the action; if an impression is not detained for a time by the influence of some feeling, it is void of effect. When the child hits upon an exercise that gives it pleasure, and is thereby led to repeat the act, earnestly and intently, the occasion is sure to be a good one for a sensible advance in fixing the whole connected train.

NATURAL OBJECTS—AGGREGATES OF NATURAL QUALITIES.

53. One of the principal forms of human intelligence consists in a permanent hold of the external world as it strikes the senses.

External objects usually affect us through a plurality of senses. The pebble on the sea shore is pictured on the eye as Form and Colour. We take it up in the hand, and obtain the impression of Form through a different organ, and with that the Tactile sensation of the Surface. Knock two together, and there is a characteristic Sound. To preserve the impression of an object of this kind, there must be an association of all these different effects. Such association, when matured and firm, is our idea, our intellectual grasp of the peeble.

Passing to the organic world, and plucking a rose, we have the same effects ; form to the eye and to the hand, colour and touch, with the addition of odour and of taste. A certain time is requisite for the coherence of all these qualities in one aggregate, so as to give us the enduring image of the rose. When fully acquired, any one of the characteristic impressions will revive the others ; the odour, the sight, the feeling of the thorny stalk,—each of these by itself will hoist the entire impression into the view. Should we go to work and dissect the flower botanically, we obtain new impressions to enter into the common aggregate.

The rapid associaton of these qualities, the quick adhesion of the sensations of sight, touch, &c., into an intellectual product, enables us to acquire a large stock of impressions corresponding to Mineral and Vegetable bodies. This is the gift of the Naturalist, who, having to retain in his mind many hundreds of thousands of distinct notions, must not put off time in the work of acquisition. In him, the sensations of sight and touch must be vigorous and enduring. Mere Colour and its varieties must make an abiding impression; unmeaning Shapes also must be easily remembered. The persistence of visual and tactual impressions must be high, and the force of adhesiveness naturally good in his case. He cannot afford a high tension of mind upon each object, owing to the great variety of things to be attended to, and hence the force of contiguity must be considerable, independently of any stimulus beyond an average interest in the subject. What is called good observing faculties must belong to the character of the naturalist; a high activity in the organs of sense, a persistent energy in the centres that sustain the movements of the eye, the hand, and the locomotive powers, together with discrimination and retentiveness. To keep up the activity of these organs for a long stretch of time demands a peculiar nervous organization. When the tendency of the mental force is in this direction, the examination of sensible objects—minerals, plants, animals, &c., is a spontaneous and sustained effort, which of itself would cause a rapid and extensive acquisition of the impressions of outward things.

The power of observation ever fresh and buoyant, the energy of the brain thrown into visual and tactile sensation, are characteristics not of the naturalist mind alone, but of all classes that deal with outward things in the concrete ; among whom we may include the navigator, the engineer, the military commander, and the poet. In those things that appeal to other senses also—as articles of food—there is an additional motive, growing out of their intense interest. So, there may be a superadded charm of the artistic kind, determining a preference, with some minds, for all objects of a nature to gratify the artistic sensibilities. But the naturalist must be above all such partialities ; to him every natural object must possess a moderate interest, and no class more than a fair share ; it is only by this moderation that he can keep his mind equal to the multitude and variety of nature.

54. From the objects of the world thus apprehended, as they strike the immediate sense, we pass to a higher group of aggregates,—things with properties not always present to the view. For example, a cup in its completeness must be conceived as containing something, as serving this purpose or use. We have to associate with the permanent sensible qualities this other quality of usefulness for some *end*, which has a special interest in it to quicken our retentiveness of the entire total. Furniture and tools and implements of every description have this superadded quality, which, however, instead of burdening the memory, rather lightens it by the spur of a special interest. All related objects are more easily fixed in the mind than those that are unrelated, particularly if the relation be an interesting one. A monarch is more impressive than a man ; a millstone is more firmly remembered than a useless block on a moor. Where the interest in industrial production is naturally high in an individual, every kind of machine arrests the regards and makes a stronger impression. We have here another example of that select or special atten-

tion, which concentrates the mind upon some things to the neglect of others, and is also in strong contrast with the catholic tendencies of the naturalist character. Not only is there a restriction as regards the objects in the narrow point of view, but the properties attended to are more limited. If a tool has a good edge, its specific gravity is a matter of indifference; if a quarry yields good building stone, the owner leaves it to others to determine its mineral composition and geological era.

NATURAL AND HABITUAL CONJUNCTIONS—STILL LIFE.

55. The things about us that maintain fixed places and relations, become connected in idea as they are in reality, and the mind thus takes on a phantasmagoric representation of our habitual environment. The house we live in, with its furniture and fittings, the street, town, or rural scene that we encounter daily,—by their incessant iteration cohere into abiding recollections, and any one part easily brings all the rest into the view. These familiar haunts exemplify the highest degree of pictorial adhesion that we can ever attain to, being impressed by countless repetitions under strong natural interest. We likewise associate a number of human beings with their abodes, dresses, avocations, and all other constant accompaniments.

Objects at a distance from our daily circle, afford the best opportunity of trying the adhesiveness of the mind for pictorial expanse. A house we have visited only once or twice, a strange street, a new scene, will put to the test the visual persistence of the mind. This case resolves itself partly into the case of coloured impressions, and partly into that of visual forms, the tenacity for colour being the essential point. A coloured decoration is quite irrecoverable, if the sense of colour is not very powerful; the same may be said of a heterogeneous and formless collection of ornaments or curiosities. The recollection of dresses turns principally upon the hold we have of colour. The interior of a room implies form, and may be retained as such; but if the sense of colour is indifferent, it will be revived only in outline. A garden, a shrubbery, an array of fields, rely very much upon the coloured element. The more irregular the outlines of things are, the more do we depend upon our tenacity of coloured impressions to make them cohere.

For the easy retention of the variegated imagery of the world about us in all its richness, a powerful adhesiveness of colour is the first requisite. This gives to the mind a pictorial character, an attraction for the concrete of nature, with all the interest that hangs upon it. We have just seen that it is one of the qualifications of the naturalist; it is also the general basis of character in the Painter and Poet, for although both these have to select, from the multitude of appearances, such of them as have an interest in art, yet it is well that they should easily keep a hold of anything that presents itself to the eye, whether beautiful or not. A luxuriant imagination implies the facility of retaining scenes of every description; nothing less could sustain the flow of Shakespeare. Although all objects are not beautiful or picturesque, yet there is hardly any appearance that may not come in well in some composition, and the poet-painter ought to be a person of strong disinterested retentiveness for everything that he sees. Any one *stopping short* at this point would be a naturalist simply; but when the poetic sense is added to lay a *special stress* upon the beautiful, grand, or touching objects, the naturalist passes into the artist. A strong artistic sense, without the broad disinterested hold of nature's concretes in general, may make a man a genuine or even an exquisite artist, but thin and meagre in his conceptions; great taste with feeble invention. Instances both of this and of the opposite coincidence—richness without delicacy—occur in all the fine arts.

It will thus appear, that no great difference obtains between the last head and the present, as regards the faculty at work. The aggregate of impressions in a single mineral, or plant, is made coherent by the same force of growth that groups these individuals together, into the totals that make up the face of nature. In the latter case, we are more completely dependent on impressions of sight; in the other, tactual inspection often enters, but even then, sight is the principal medium of retention. Between the apple that appeals to every sense, yielding a complex notion made up of all, and the starry heavens that affect the eye alone, there is less of intellectual difference than there seems, for the apple is retained in the mind principally as an object of sight.

56. Among the greater aggregates implied under the present head, I may include those artificial representations intended to aid the conception of the outer world, as, for example, Maps, Diagrams, and Pictorial Sketches. A very great utility is served by these devices, and much intellectual power and practical skill depend on our being able to associate and retain them. The Geography of the globe is summed up in an artificial globe, or a set of maps, with outline, shade, and colour, to correspond with the differences of sea and land, mountain and plain. There are very great differences among individuals in the hold that they take of a map, with all the information it conveys. It appears to me that a good adhesiveness for colour is the important element in a case of this kind, just as in the recollection of the actual surface of a country. It is a case of that facile retentiveness of a great multitude of impressions, that contrasts with the severe hold of a few selected ones; an extensive rather than an intensive mind. Next to a map, we may class Natural History sketches, which contain a great variety of appearance depending mainly upon differences of colour. Anatomical diagrams and machinery are much of the same nature, but incline to the diagrams of abstract science, where attention has to be strongly concentrated on narrow points. When we come to the figures of Euclid, colour entirely disappears as an element; the pictorial retentiveness above descanted on, is of no avail. Form is everything, and that Form is not various but limited, and exceedingly important. This illustrates, by contrast, the power of seizing nature's aggregates and concretes, where thousands of distinct impressions must fall into their places and cohere with ease and in a short time. A crowded theatre and the forty-seventh of Euclid are equally objects to the eye, and also to the con-

ceiving mind when they are gone; but the region of the brain that determines the adhesiveness must be quite different in the two cases; in the one, we have colour and variegated form, in the other, a few regular forms with negation of colour.

57. There is an interesting class of artificial conjunctions, wherein the obvious appearances of things are associated with other appearances brought out by Manipulation and Experiment. The properties of a Mineral—the complete notion that we can attain respecting it—are a combination of the sight and touch with the artificial aspects made by scratch, a fracture, the blowpipe, the application of an acid, the measurement of the angles. A complex impression is thus made up and, by repetition, stamped on the mind; at an after time, any one of the characteristic properties will revive the total conception of the mineral. So in Chemistry, each substance is conceived not simply as seen and handled by itself, but as acted on by many other substances, by changes of temperature, and so forth. The chemist's notion of Sulphur is a large aggregate of appearances and sensations produced in various ways; it is, in fact, the notion of a great collection of substances—the compounds of sulphur—as odour of burnt brimstone, oil of vitriol, salts of sulphuric acid, compounds of sulphur with metals, &c. In like manner, the properties of a plant are not completely summed up and aggregated in the mind, till in addition to all the aspects it presents by itself, other aspects are taken along with it, brought out by dissection and manipulation. These cases are nearly parallel to an example occurring under the immediately preceding head, namely, tools and machinery, where the present aspect has to be augmented with other appearances, manifested when they are put to their practical uses.

In these mineral and chemical aggregates, there is great scope for proving the force of contiguous association, but still more for testing the disposition to dwell upon *artificial* combinations, the results of previous analysis or forced separation of natural conjunctions. Science, as I shall afterwards have occasion to illustrate, is repellent to the natural mind, from the necessity of disassociating appearances that go naturally and easily together, of renouncing the full and total aspect of an object by which it engages agreeably the various senses, and of settling upon some feature that has no interest to the common eye. Those compounds of sulphur that have to be conjoined with the simple substance as a part of its idea, are constantly viewed by the chemist under the one aspect of composition or decomposition in the contact with other bodies; the appearance of any single substance to the eye signifies nothing, and may be wholly irrelevant to any purpose of his.

SUCCESSIONS.

58. If we except complex and coinciding muscular movements, and the concurrence of sensations through different senses at the same moment, all associations are successive to the mind, seeing that we must pass from the one to the other, both in the original experience and in the subsequent recollection. The features of a landscape can be conceived only by successive movements of the mind, as it can be seen only by successive movements of the eye. But I here contrast the Successions, movements, events, and changes of the world, with Still Life, the *status quo*, or the contemporaneous aspect of nature, and I mean now to allude to the procession of the universe in time, as a consequence of the properties of movement and change impressed upon it.

We may notice first the successions that go round in a *cycle*, without shock or interruption, as day and night, the phases of the moon, the course of the seasons. The different aspects presented by the sky above and the world around, in the course of the solar day, are associated in our minds in their regular order, and anticipated accordingly. This cyclical association makes up one part of our knowledge, or experience, of the world, and guides our actions in accordance with it. Such slow and tranquil changes, become coherent under almost the very same conditions, as the aspects of still life that we view in succession by moving from place to place. The two cases are very different in themselves, but to the mind the contemporaneous in reality is the successive in idea. The chief distinction lies in this, that the flow of *moving* nature is associated in one constant direction ; whereas the mental association of *still* nature is backward and forward in various directions. But the same mental adhesiveness that can embrace the one, will with equal facility embrace the other.

A second class, under the present head, is comprised by successions of *evolution*, as the development of a plant, or an animal, through all its stages, from the germ to the decadence. The associations of these, as they occur in nature, make up ur knowledge of the history of living things. The peculiarity of the case is the continuity and identity of the main subject, and the likeness that prevails in the midst of change. Both these circumstances assist in impressing the different stages upon the recollection. If we have already formed an enduring picture of a fir sapling, we have not much difficulty in conceiving the same merely expanded in dimensions, the form and texture remaining the same ; and so with any other plant or animal. Where a creature undergoes a radical transformation, as a butterfly, or a frog, we have to conjoin two different appearances. In reality, the stages of evolution are more frequently learned by seeing them altogether on different subjects, as in a plantation of trees, or in the mixture of all ages in human society. The evolution of living beings, plants, or animals, in their growth and decay, usually excites a strong and interested attention, which operates in fixing the successive stages in the recollection. The same happens in historical evolutions, and it is particularly aimed at in the artificial evolutions of the drama and the romance. There is also a strong interest attached to the successive stages of a constructive operation, a process in the arts, a case in a court of law, or the course of a disease. A mind naturally adhesive to sensible impressions would, as a matter of course, acquire out of its opportunities of observation a large store of these successions, but the bent of interest concentrating the mind upon some, in preference to others, is perhaps the most efficient circumstance. One man is engrossed with the progress of the field and the garden, from the seed to the fruit; another looks with especial eye to the human development in body or in mind. The romantic interest seizes men generally, and fixes with ease the successions of a plot or story.

Apart from this circumstance of special interest in the unwinding of the future, the associations of evolution are not materially different from the conjunctions of still life, these being also unavoidably successive. The pages of a book, or the houses of a street, exist contemporaneously, but cannot be viewed otherwise than successively. The mind formed to associate with little repetition the flowers of the same garden-plot, can likewise retain the different phases of the growing plant. The lapse of time between the different views may occur when things are contemporaneous, no less than when they succeed one another.

59. Relating to the recovery of trains of imagery there is a fact of the nervous system to be attended to; namely, that a mental movement once set on tends to persevere and feed itself. We can remark in the eye a tendency to continue in any motion when commenced, as in following a projectile, or in sweeping round the sky line that bounds a prospect. The spontaneous vigour of the moving organs carries them forward in any direction that they may chance to enter on; and, in addition to the spontaneity of the active system, the stimulus of the sensation itself operates in sustaining a movement that has been commenced. Thus it is, that the eye so naturally follows out a vista, or traces the course of a stream. Seeing the beginning of a straight line, or the fraction of a circle, we feel ourselves led on to the conception of other parts hidden from the view. A tall spire carries the regards upwards far into the heights beyond itself, while a descending current gives a downward direction to the bodily or mental eye. Just as we acquire an almost mechanical persistence in walking, or in handling a tool when once under way, so the sight falls into a given movement, and goes on of its own accord, over the course that has been chalked out for it. When our eye sweeps along the line of a procession, it acquires such a persevering tendency that it is apt to go beyond the termination until its view in that direction is completely exhausted. When a succession of objects is very rapid, as in a railway train, it some-

times impresses a diseased persistence on the visual circles, and we feel the dizzying sensation of everything about us being still in motion. Like all the other actions of the brain, this persistency has a moderate and healthy pace, which easily subsides, and a hurried and diseased pace that we cannot check without great difficulty.

Now, in the operation of recalling the steps or members of a succession at the prompting of those that go before, our recollection is aided by this tendency to go forward, or to leap from the one at present in the view, to the next in order. This restless forward impulse, in some constitutions very strong, will not suffice of itself to recall the next member without an adequate adhesive growth between it and the preceding, but it counts for something in the act of recovering any object that we are in want of in that particular train. It determines very much the degree of rapidity of the mental action; and from this circumstance gives a very marked character to the individual. It does not confer intellectual power—this depends on the proper forces of the intellect—but it favours promptness and quickness in perceiving whatever it is within our power to perceive, a quality often useful in the emergencies of life.

60. The successions designated as *Cause and Effect,* are fixed in the mind by Contiguity. The simplest case of this connexion is that where our own actions are causes. We strike a blow, and a noise succeeds, with a fracture. The voluntary energy put forth in the act, becomes thenceforth associated with the sound and the breakage. It may be remarked, that hardly any bond of association comes sooner to maturity, than the bond between our own actions and the sensible effects that follow from them. There are reasons for such unusual rapidity of growth; certain circumstances can be mentioned that favour the concentration of the mind upon this particular sequence.

In the first place, these effects are often themselves energetic, startling, and impressive. This is indicated by the employment of the word 'effect' to mean what yields a strong sensation, something that takes the mind by storm, and excludes for the time all other objects of attention. The stronger kinds are those that produce some startling change in the still routine of things. The firing of a cannon in the quiet of the night; the shattering of a window; the upsetting of a table covered with crockery; the kindling of a conflagration; the taking away of a life,—are all intensely exciting to the nervous system; and the excitement takes the particular form of engrossing the entire action of the mind for a length of time. It becomes difficult to form any other adhesions at such a moment; the wits are occupied in the direction given by the violent stimulus. One single occasion is sufficient to connect for ever one of these startling events with its immediate antecedent or cause. According as the effects are milder in their character, and slower in their operation, their connexion with the causes is less speedily established in the circles of the brain. But as a general rule, causation, when distinctly apparent,—that is, when the two or more members of the succession are clearly ascertained and contemplated by the mind,—impresses itself much more easily than the successions of things in a sweep of landscape, or the stages of vegetable or animal life. There is in man a natural liking for effects, owing to the mental stimulus they give; and much of the pleasure of life is made up of this kind of excitement.

But we must remark, in the second place, that the active impulses of the human mind, which are in many instances the causes of the effects we see, and are assumed as the type of all other causes, are very easily impressed on the recollection as permanent ideas; that is to say, it is easy to recall the notion of any action of ours that has been concerned in producing a startling change. Our moving members being always with us, their movements are the most familiar facts that we possess; it is easy to remember a kick, a wrench, or any other common action. Hence, in a succession of two steps, one a familiar action of our own, the other a striking effect on our senses, the first is already formed into a permanent idea by repetition, the second arrests a powerful current of attention, and the fixing of the two is therefore comparatively rapid and sure. Unfamiliar actions as causes are not readily remembered; hence effects of intricate construction and mechanism do not impress themselves without due repetition.

In imagining the causes of unknown effects, human power is the first thing suggested, from the facility the mind has of entering into this cause, and also from the pleasure derived by the very idea of human energy put forth in the accomplishment of effects. The universal tendency to personify all the powers of nature has its origin in this circumstance ; and is a confirming illustration of what I have been endeavouring to enforce in the present paragraph.

61. The action and reaction of one man on another is a notable example of cause and effect, under circumstances favourable to an impressive recollection. In this case, both the cause and the effect are human manifestations, readily conceivable from the fact that we ourselves have been frequently actuated in the same way. When we witness, for example, an encounter of hostility, both the provocation and the retort are actions that we can completely realize from our own past experience. Here, too, as in the cases above noted, the rousing of a human being from quiescence to animation, is a startling effect which arrests and impresses the beholder. Most persons are susceptible to these sudden changes in the expression of living beings ; they constitute a great part of our interest in society and in the drama. By noting those various movements of expression, in connexion with the causes of them, we become impressed with innumerable sequences of cause and effect, of which one member can at any time recall the other ; and the recollections thus formed make up a large portion of our knowledge of the ways and characters of mankind.

Some minds are peculiarly susceptible to this class of effects ; the movements that constitute the expression of men and animals take a deep hold of their attention, and are proportionably impressed on the memory. Such minds are thereby rendered more than usually knowing in human nature ; while at the same time they feel a lively interest in the numerous manifestations of living creatures.

62. Our impression of any individual man or woman is made up of their permanent image, and their various movements and activity, in a number of situations and circumstances. These, repeated to our view, at last fix themselves in the mind with sufficient force to be revivable on the occasion of any link being present. Thus we have seen a person made angry by a blow; we connect the occurrence with the experience of anger in our own minds, and this connexion is an item of our knowledge of his character. When the anger is brought before our view we are reminded of the blow as a cause; when the provocation is present, it recalls the anger. We can use this sequence for the purpose of either avoiding or bringing on the effect; we can generalize it as a fact of human nature in general; we can reproduce it dramatically; we can explain other men's anger by it. Other sequences come in addition to this, and by sufficient length of time and opportunity, we can associate together cause and effect through the whole cycle of an individual's ordinary actions. We are then said to know a man's character. Our knowledge of animals is of the very same nature.

The peculiar susceptibility to the human presence now spoken of, may arise out of several different sources. To the natural history sense all visible imagery is impressive, the human face and form among the rest. The susceptibility to visible movements is a distinct element wherein minds differ, and with it is connected the sense of forms, and particularly the human. The sympathetic disposition, as contrasted with the egotistic, or self-engrossed, is in favour of the same turn for noticing other people's ways. The artistic sense finds much of its material in the human subject, and is thereby made alive to the manifestations of living men. To all these causes of special attention to the phenomena of humanity, we are to add the strong passions and emotions that have our fellow beings for their subjects, and we shall then see how it comes that the natural, if not 'the proper, study of mankind is man.' The interest of external nature viewed by itself is cold in comparison, and hence its sequences make a much smaller part of the acquired ideas of causation in the generality of minds, than those relating to living men and women.

In the foregoing view I have purposely omitted the mention of *scientific* causation.

MECHANICAL ACQUISITIONS.

We have now touched on the chief fundamental classes of associated things under Contiguity. What remains is to carry out the illustration of some of the preceding heads into the several great departments of intellectual acquirement.

63. Under Mechanical Acquisitions, we include the whole of handicraft industry and skill, as well as the use of the bodily members in the more obvious and universal actions of daily life. Military training, the exercises of sport, recreation, and amusement, the handling of tools in every kind of manual operation, the care of the person, are all so many acquired or artificial linkings of action with action, or action with sensation, through the operation of the adhesive force of the brain.

I have no doubt that the first condition of high success in all these acquirements, is the existence of a vigorous and various spontaneity of the active organs concerned; the forces of the brain must especially direct themselves into the channels of bodily movement. This makes the Active Temperament, the natural turn for active display.

The delicacy of the *senses* concerned in the effect to be produced must next be taken into account, when we would enquire into the sources of bodily acquisition. If the operation is to make a paste, or bring out a polish, the Touch is the testing organ, and must have the requisite delicacy; if the work is judged by colour, the Eye must be duly sensitive; if to play on an instrument, the Ear must discriminate the shades of sound. However flexible and powerful be the active organ, it can never transcend the sense of the effect produced. The most delicate fingers are useless for musical performance, when the ear is unsusceptible of a corresponding delicacy of musical perception.*

These two conditions being recognized, we may next assume that there is a certain force of adhesiveness belonging to each individual character, in some more and in others less. It may be difficult to demonstrate that such a difference remains after allowing for all circumstances and conditions; on the other hand, it would be still more difficult to show that it does not exist. In our experience of human beings, we are accustomed to every imaginable form of inequality within certain limits; the stature, bulk, complexion, muscularity, digestive and respiratory vigour, circulation,—are constantly varying, and the functions of the brain cannot be proved to be free from the like inequalities among individuals.

Much more modifiable than these three conditions, although still growing out of the natural character, is the tendency to concentrate the energy of the brain upon bodily exercise, through the medium of the fascination that it gives, or the agreeable emotion connected with it. This fascinating and agreeable emotion maintains the cerebral currents in that particular channel in preference to others, and brings on the plastic adhesion in a corresponding degree. For example, when the operation of drawing or sketching has from any cause a peculiar charm and power of satisfying the mind, it draws the entire stream of mental attention upon itself; the individual is never weary of the occupation; the adhesive action is monopolised upon one subject, instead of being dis-

* As regards many kinds of mechanical manipulation, the muscular sensibility counts twice, being a property of the organ, and also a property of the sense. Thus, in handling a dough, or tightening a string, the sense concerned is muscular, and the nice graduation of the arm and hand to suit the desired effect is also a muscular discrimination. Hence manual tact, or skill in working with tools and instruments, is specially dependent on the muscular endowment. Even where the effect is judged, not tactually, or so as to bring in the sense of resistance, but by the eye, the ear, or the taste, the flexibility and measured graduation of the active organ involves the discriminative feeling of expended power, which attaches to the muscular system, and is no doubt unequally manifested in different constitutions.

tributed over many. This circumstance determines *special* mechanical gifts and acquirements, even when the natural activity is equally distributed over all the members.

64. We must now advert to the circumstances, favouring mechanical acquisition, that depend not on the inborn peculiarities, but on the manner of going to work. This is the practical point. The training of recruits in the army may be taken as a good example of how mechanical discipline should be conducted. As I am informed, the system there pursued is this; the recruits are drilled three times a day, morning, forenoon, and afternoon, for about an hour and a half or two hours each time. They have thus a meal and a period of rest between each drilling. I am not aware of any better general arrangement that could be devised, for attaining the greatest results in the least time. In the first place, the moments of greatest bodily vigour and freshness are to be chosen for the work of discipline. In the next place, the exercise ought not to be continued too long at a time; when the muscles and brain are once thoroughly fatigued, the plasticity is at an end, and nothing is gained by persisting farther. Lastly, the lessons ought not to be too short: that is to say, a certain time is requisite to get the body into the set that the exercises require. Scarcely any exercise of less than half an hour's duration, will take a decided hold of the system. To hit the mean between the period of thorough engagement of the organs in the work on hand, and the period of excessive fatigue, constitutes the practical judgment of the drill-master in every department. In the army, where the time of the learners is completely under command, the system of three daily lessons with intervals of rest and refreshment is chosen as perhaps the best arrangement; the mental disgust apt to be generated by occupying the entire strength of the system upon one class of operations, is not taken into account. In the discipline of early education in general, there is more variety of interest, and it is possible to occupy nearly half the day continuously upon the work. But the army system is the model, in circumstances where it is practicable

to bring the pupils together, early morning, forenoon, and afternoon.

The rule for the exercises of the learner is very different from the rule for the practised workman at his work. In this last case, long continued and uninterrupted application is best. But in learning a new thing, the stress of the attention very soon fatigues the brain; so does the committing of blunders and false steps. Moreover, the organs unhabituated to an operation are less able to sustain it. But when the mechanical routine is perfect, and the parts strengthened by long practice, it is unnecessary to halt every two hours; it is much better to continue at work for four, five, or six hours, as the case may be.

The apprentice learning a trade keeps the same hours as the workman, and is not treated as an army recruit or a school-boy. But in his case the plan of proceeding is different. The apprentice, having gained some one single step, before taking another, goes on repeating that process exactly as a productive workman. He gets much more time for his education, and has it largely diluted with his routine work. This makes his situation tolerable during the long hours of his working day. It is when the rate of acquisition is pushed to the uttermost, and actual production disregarded, that the system of long intervals of rest is most necessary.*

A learner's progress will be vitally dependent on the absence of any other engrossing passion or pursuit. This makes it of so great consequence to have a certain amount of exclusive liking for the subject.

VOCAL OR LINGUAL ACQUISITIONS.

Although the acquisitions of the articulating organs, in speech and languages, follow the very same general laws as other mechanical acquirements, their importance as a branch

* I should remark, however, that it is unnatural, and on various accounts injudicious, to require an apprentice to work the full time of a fully-trained man.

of human intelligence claims for them a special notice. I shall advert first to the vocal exercise of singing.

65. The acquiring of musical airs and harmonies by the voice depends on the Vocal Organs, on the Ear, and on certain Sensibilities that may be supposed to pass beyond the ear.

As regards the Vocal Organs themselves, they must necessarily be adapted to the production of musical notes through a sufficient register. They must further be so related to the nervous centres, as spontaneously to give birth to these sounds in great variety, that is to say, in many shades of difference. It belongs to the natural endowment of the centres, that they shall act in many degrees of energy upon the respective muscles, so as to give at the very outset a large variety of sounds to be caught up, associated, and artificially reproduced. The narrow or wide compass of these primeval and chance utterances—the result of the spontaneous discharge of nerve force from the centres—is the material circumstance in determining the flexibility or natural variety of the voice.

Next comes the Ear, the regulator of the effects produced by the spontaneity of the voice. With a view to music, as already noticed, the ear must be discriminatingly sensitive to pitch, and to the harmonies and discords of different pitches. This sensitiveness rules the action of the voice, and reduces its wild utterances into regular modes productive of musical effect.

We have also taken for granted that a discriminative ear will be a retentive ear, so far as the retentiveness depends on the quality of the sense. The enjoyment derived from the art is, as in other cases, a motive to the attention.

The acquisition of instrumental music may be explained by substituting, for the voice, the action of the hands or the mouth, all other considerations remaining the same.

It would not be difficult to apply a test to the musical adhesiveness of different persons by fixing upon a corresponding stage of progress, and counting the number of repetitions necessary to learn a melody. The most enormous differences in this respect may be constantly observed; two or three repetitions being as good to one person as two or three scores of repetitions to another.

66. In Articulate Speech we have likewise a case of vocal action guided by the ear, but with great difference as respects both the action and the feeling. The power of articulating brings out a new series of movements, those of the mouth; while the nice graduation of the force of the chest and of the tension of the vocal chords, required in singing, is here dispensed with. The sensitiveness of the ear to articulate sounds may partly agree with, and partly differ from, the musical sense.

The first stage of speaking is the utterance of simple vowels or of simple consonants with vowels attached, as *wa, ma, pa, hum.* The sound '*ah*' is the easiest exertion of the mouth; the other vowels, *e, i, o, u,* are more difficult positions. The labial consonants, *m, p, b,* usually, but not always, precede the dental and guttural; the closing of the lips being a very easy effort. I am not aware that the dental letters, *d, l, t, n,* are more easy than the gutturals, *k, g,* but the aspirates are perhaps more difficult than either. Of the vibrating sounds, the hissing action of the *s* is readier got at than the *r*. For this last letter *l* and *w* are used, as *lun*, *wun,* for *run.*

New difficulties appear in the attempts to combine two consonants into one utterance; as in syllables that begin and end with a consonant. Some of these are found easier than others; *mam* is easier than *man*, and this than *mug;* for the reason that it is less difficult to combine two labials, than a labial with a dental, or a guttural,

There are two stages in the acquirement of articulate sounds; the first is the stage of spontaneous utterances, and the second the stage of imitation. In both, the natural flexibility or variety of the organs must be coupled with delicacy of the ear for articulate effects, in order to make rapid progress.

The joining of syllables and words into continuous speech brings into play a further exercise of the associating principle. We must next add the element of Intonation or Cadence. This is among the accessories of musical effect, having little regard to what are the principal circumstances in Music,—namely, pitch, with its harmonies, and time. In speaking, the voice rises and falls in pitch, but not with any nice or measured gradation; the degree of stress or emphasis, the change from the abrupt to the long-drawn utterance, the alternate rise and fall, the descent and gradual subsidence at the close, are among the characteristics of cadence, or the music of speech. A great susceptibility to intonation marks some constitutions; when coupled with a flexible articulation, it gives the power of becoming an elocutionist.

The earliest acquisitions of the purely verbal kind, such as prayers, rhymes, and stories, bring to the test the natural force of the verbal memory. The less the appreciation of meaning, the better the criterion afforded of pure verbal adhesiveness. This quality, when strongly manifested, is the basis of lingual scholarship and of what is called memory by rote. It manifests the presence of a good articulate ear, and probably a high degree of the adhesive association by contiguity. The power of memory of the ancient bards, which had to retain to the letter long compositions, and the kind of erudition ascribed to the Druids, would exemplify it, although in these cases, natural deficiency could be made up by iteration,

67. In learning the Mother Tongue, the process is partly a verbal one, and partly an association of names with objects. Here there is a complex effect. For, in associating two things of a different nature, as a sound on the ear, with an appearance to the eye,—the name 'sun,' for example, with the visible effect,—the adhesiveness depends on the degree of impression produced by each. In fact, we remember much sooner the names of things that impress us than the names of indifferent things. Hence the progress in the use of names depends in part on the tenacity of the mind for the corresponding things. The acquisition of our mother tongue is something exceedingly vast, seeing that it implies the conception of all the objects

named therein; and the use of names proceeds with the experience of things. Doubtless in this case, too, the force of mere contiguity counts as the prevailing circumstance; for, in order that all objects indiscriminately may yield tenacious impressions, this power must be naturally great, and the same circumstance would serve to foster the growth of the adhesive link between name and thing. The verbal scholar has thus something in common with the intellect for natural history.

When we come to the case of Written Language, the resemblance just hinted at is still closer; for in that the object is not an articulation but a visible sign, and the tenacity of its adherence will depend on the eye and its connections in the brain. In acquiring language through the medium of writing or print, we may either keep a hold of the visible symbols as pictures in the eye, just as we remember maps and diagrams, or we may pass from these to the vocal pronunciation, and retain it by articulate adhesiveness. It is not necessary to read aloud in order to transfer the work from the eye to the voice, a mere whispered or muttered articulation, a mere *ideal* rehearsal, will become coherent. In fact, I believe we retain written language by the help of both methods, or by a combination of trains of *symbols*, as seen by the eye, with trains of *articulations* rehearsed by the voice. This is an example of Compound Associations, to which I shall devote a separate chapter. Notwithstanding this division of labour between sight and vocalisation in retaining written speech, it is obvious that a good retentive eye for alphabetic forms is an element in the intellect of the scholar. In the adhesion of forms generally, I have classified three different kinds retained by different modes of cerebral force, namely, the Mathematical, the Artistic, and the Arbitrary. The last class are the most numerous, and individually the least important; all that needs to be retained in them is some characteristic point wherein each is distinguished from the rest. The recollection of a vast multitude of alphabetical compositions demands a strong natural cohesiveness of Contiguity, for they will not afford an intense concentration of the brain, as in the case of the few and important forms of Geometry and the other sciences. On the whole, therefore, I repeat, there is much of a common character in the Scholarly and in the Natural History intellect.

68. In acquiring Foreign Languages by the usual methods, we have more of the purely verbal than in the mother tongue. We do not usually connect the names of a foreign language with the objects, but with the names already learnt. We may connect sound with sound, as when we are taught orally, articulation with articulation, or mark with mark in the eye. Thus 'domus' and 'house' may be associated as two sounds, two articulations, or two sights; usually we have the help of all three ways of linking. Including the act of writing down words, there are no less than four lines of adhesion, involving two senses and two modes of mechanical exertion. What the hand has shaped, persists as an idea in the moving circles of the arm, which idea tends to remain coherent, and afterwards to recover itself in full; it may thus prove a help to the other links in the recollection of names and compositions.

In the absence of a good contiguous adhesiveness for indifferent things, such as arbitrary sounds and symbols, lingual acquisitions are necessarily laborious and difficult, and an unprofitable waste of mind.

69. Oratorical Acquisition introduces the element of Cadence. This is partly created in ourselves by the spontaneous flow of voice becoming modified to please each person's own ear; by which means we have *originality* of cadence, whether the quality of the creation be high or low. But for the most part, it is acquired by hearing others, like vocal melodies. Many forms of cadence prevail in the world. Each nation has characteristic strains of this kind; the foreigner, never so perfect in the pronunciation of the words of another language, is detected by the absence of the national manner in his spoken melody. Provinces differ in the same country: English, Irish, and Scotch have their peculiar strains. The orator is a man able to produce a great variety of the richest cadences, just as a singer has the command of many vocal melodies. To fit articulate language into the forms and falls

of musical articulation is the orator's art. We have no artificial means of expressing or representing the oratorical rhythm, so as to preserve the manner of a great orator, or to mark the differences between one cadence and another; the notation of the elocution manuals is not carried far enough for this. But we can easily imagine the process of oratorical acquirement, and we are able to specify the points that it turns upon. The abundant and various action of the voice by primitive constitution, the susceptible ear, the opportunity of hearing many and good varieties of the elocutionist's display, and a strong sustaining interest in this particular effect—are the preliminary essentials. A rapid fixing of this class of impressions will be favoured by all those circumstances; while a good general adhesiveness of the brain should also concur. When the individual has by his own exertions, following the lead of his ear, and using all his tendencies, natural and acquired, struck out a fine train of utterance, it is desirable that this should be ready to fix itself permanently for future uses, and for still further acquirements; no art can be carried to perfection, in a mind where the finest effects disintegrate as fast as they are produced.

Cadence, although properly a spoken effect, is transparent through written composition. In pronouncing the language of Johnson or Milton, we fall into a distinct strain; this, too, we can acquire and impress upon compositions of our own. We naturally drink in the cadences most suitable to the natural march of our own vocal organs, and those that possess the greatest charm.

RETENTIVENESS IN SCIENCE.

70. By science, I here understand the artificial symbolism and machinery, requisite for expressing the laws and properties of the world, as distinguished from the actual appearances of things to the common eye, of which I have already spoken under the heads of natural conjunctions, successions, &c. Thus, a treatise on Astronomy is a mass of algebraical calculations and numerical tables. Nothing can well be more

unlike the aspects of sun, moon, and planets, than the algebraical formulæ and numerical tables expressing the scientific relations of these bodies.

The Object sciences range from the extremely abstract and symbolical, where nature in its obvious garb is utterly excluded, such as Mathematics, to the more concrete subjects of Natural History, wherein some part of the acquisition really consists in storing up the common appearances of animals, plants, and minerals. The laws of contiguous association differ, according as any one branch is nearer the one or the other extreme. Thus, theoretical Mechanics, Astronomy, and Optics, come under the mathematical class. The experimental parts of Chemistry, Physiology, and Anatomy approach the other end of the scale: in these, the adhesiveness of the natural history mind for sensible appearances and properties, is of the highest consequence.

To advert to the more abstract sciences,—which represent science as most opposed to our scientific pictures of the things about us,—the symbols of Arithmetic and Mathematics generally, the symbols and nomenclature of Chemistry (combining proportions, atoms, &c.), the nomenclature and abstractions of Physiology (cells, corpuscles, ultimate fibres, secreting glands), require a peculiar cast of intellect for their acquisition; and they are so much of a kind that the mental adhesiveness suited for one would not be much at fault in any other. They are a class of bare forms not remarkably numerous, which are to be held in the mind with great tenacity, and to be taken as the sole representatives of all that is interesting in the world. The self-denial that enables us to dwell among the algebraical symbols, and to concentrate the whole force of the brain upon these, to the exclusion of all those things that gratify the various senses and emotions,—this abnegation, so to speak, of human interest, is the moral peculiarity of the mathematician. To be able, for the sake of the ends of science,—the attainment of truth and certainty as to the causes of things,—to force the mind to entertain willingly conceptions so meagre as the diagrams of Geometry or the symbols of Algebra and Chemistry, proves that the cerebral currents go naturally towards the fixing of mere visible forms, such as have no interest in themselves, but serve as the instruments of our practical ends. It is not necessary that the mathematical mind should be entirely destitute of attraction for colour and beauty, and picturesqueness, and music, but it is necessary in such a mind, to cast all these out of the view, and to grapple with the artificial symbols that express the most extensively important truths of the world. The interest in attaining the sure and certain laws of the universe, is the motive for immersing the mind in such a cheerless labyrinth of uncouth characters; this motive being once strong in an individual, the only other requisite is great natural adhesiveness for arbitrary symbols, an adhesiveness which, if depending on local causes, results, in a considerable measure, from the moderate degree of the competing sensibility of the eye—that for Colour. The symbols of a science are few in comparison with the words of a language, but the hold of the one must be much more severe than of the other. A circle used as a diagram in Euclid, must make a far deeper impression than a circle as an alphabetic letter. With Euclid's circle has to be associated innumerable lines and constructions, which can never be all presented to the eye at one time, but must be firmly held in idea alone, ready to be brought up on the hint being given; to the circle of written language there is no such array of ideal appendages; it is conceived simply as it can be written, and only as regards its visible difference from the other letters of the same alphabet. It is this complication of visible figures, with a multitude of associates not possible to exhibit at once to the eye, and which yet must all be at command, that gives such an intellectual character to scientific reasonings. The Geometrician must retain, in connection with a circle, all the constructions of Euclid's Third Book, and, if need be, all the constructions that precede and give foundation to these, and likewise the language that represents in words what cannot be presented to the eye; all which puts to a severe test the cerebral adhesiveness for uninteresting forms. Moreover, this adhesion must get firm rapidly at every step, otherwise the earlier steps of a deduction would be lost before the later were fixed. In an algebraical problem, where x is put for one thing, and y for another, the learner must, by the force of a single repetition, remember all through that these letters stand for such and such things. Persons not rapidly impressed with these arbitrary connections, are unqualified for mathematical operations.

In Arithmetic, the ciphers, their additions, subtractions, multiplications, and the decimal system of reckoning, are of the nature of associations of symbolical forms, and require the firm concentration of the mind upon arbitrary signs for the sake of the end they serve. In Algebra, the same operation is carried to a higher complexity, but without any difference in the nature of the machinery. In Geometry, a host of definitions have to be remembered; that is, a line, a space, a square, a circle, must be associated with certain other lines and constructions, with the assistance of language. 'A circle is a line equally distant from a central point.' The association here is between the visible aspect of the circle, with its central point, and a line drawn from the centre to the circumference, which line is a representative line, and may be drawn anywhere round the whole compass of the figure. This principle of representation is a thing of the intellect entirely; for, in addition to the sensible object, there is a fact, or a multitude of facts, that cannot be made apparent to the eye at one and the same moment. With the sensible appearance of a triangle in Euclid, there is a movement of the mind away from this to other triangles, seen or remembered, and we are not allowed to make any affirmation about that triangle, or to take any notice of any feature of it, without going over other triangles, to see if the same holds in these also. Such is the restraint imposed upon us in dealing with representative objects in general, among which scientific diagrams are to be classed. Instead of occupying ourselves wholly with the sensible present, we must be continually passing to and fro between it and the ideal absent, thus checking our movements by incessant comparison. All this proceeding is contrary to the bent of the natural mind. It shows how the operation of intellect transcends the operation of sense, in this way, namely, that intellect can mix any amount of the past and distant with the consideration of the present, a power extensively drawn upon in the abstract sciences.

In the experimental and concrete sciences, as Heat, Electricity, Chemistry, Anatomy, and Natural History in general, the consideration of the actual appearances to the senses, mixes largely with the artificial symbols and abstractions, and hence the value of a good adhesiveness for colour and shape, for touch, and even taste and smell, in storing up the objects of those sciences. The Mathematical mind may be quite at fault here, just as the Natural History mind has no chance to be suited for the mathematical group of subjects. In Anatomy, for example, there is a vast detail of bones, ligaments, muscles, blood vessels, nerves, &c., and the visual adhesiveness for mere colour is an element in the recollection as with a map, or a pictorial landscape. The tactual adhesiveness is of some value in this class of objects, and in the various objects of the natural history class, minerals, plants, and animals, all which are handled as well as seen. Thus it is that there are, for the Object of sciences, two classes of scientific minds, represented by the extreme terms of Mathematics and Natural History, the abstract or artificial, and the concrete or real. As regards the modes of human interest or fascination, a greater number of classes could be made out: pure mathematics, as in Algebra and Geometry, would have a different set of votaries from mathematics applied in Mechanics, Astronomy, Optics, &c.; and the natural history group would be both separated from experimental Physics and Chemistry, and broken up into its component members, Mineralogy, Geology, Botany, and Zoology.

71. In the next place, as regards the subject world, we have one comprehensive science, termed Mind, Mental Science, Mental Philosophy, Psychology, &c.

Although the science of mind comprehends many phenomena of an Object character, namely, all the physical accompaniments of mind, and all the outward displays of human action, thought, and feeling, it is nevertheless based on the consciousness possessed by each of our own mental states. The taking cognizance of the facts of our own mind, as phenomena to be known and studied, is one of the meanings of the name consciousness. A better designation is self-consciousness, or the power of introspection. Locke applies the name 'Reflection' to this operation; it has also been called the Internal Sense, because it is, to the subject world, what the External Senses are to the object world.

There is, in some individuals, a special aptitude for this department of knowledge. An abundant recollection of subject states—of feelings and ideas considered as to their mental sequences—is necessary to the mental philosopher, and to all persons requiring a knowledge of mind for their respective vocations. Among these we may instance the Poet, the Historian, the Orator, the Politician, the Teacher, the Preacher. It is no easy matter to lay down the precise intellectual condition of the special retentiveness for the phenomena of mind. We have not here the advantage of a distinct organ to appeal to, as with the pictorial memory, or the musical memory; and yet it is an indisputable fact, that feelings and the successions of ideas, considered as knowledge, are better discriminated, identified, and remembered by some than by others.

A good general adhesiveness, directed upon this region in consequence of some strong interest in the laws of mind, would obviously explain a part of the case. But if we are farther to inquire into the circumstances that confer a select and special power of retaining subject states in the memory, like the susceptibility to colour applied to the recollection of visible images, we have only negative conditions to appeal to. Given a certain plastic energy of the mind, that energy will be directed, either upon the object world, or upon the subject, or upon both, in varying proportions. If there be an almost exclusive bent towards the outward, there will be the minimum of attention paid to the inner world of the subjective consciousness. If the outer world attracts us in only a moderate degree, there will be large surplus of force available for the other. Now, it is not difficult to assign the forces and dispositions that constitute our Object regards. They follow strictly the object side of our being, namely, movement in the first instance, and, in the next, those sensations that, by connecting themselves closely with movement, are looked upon as object properties.

The first consideration, then, that determines our objective tendencies is great spontaneous activity, or a proneness to muscular action in all its forms. In some minds, the forces of the system are profusely determined towards bodily movement and activity. This induces a preponderating object attitude, and a correspondingly reduced subject attitude. A certain amount of subject existence must belong to every sentient being: pleasure and pain must always be recognized and acted on. But the subject existence may amount to little beyond pleasure and pain, as motives to the will. That further tendency, of making these a matter for study and reflection, will be prevented by the intense determination of the powers to bodily movement. It is when the outward determination is less than ordinary, that the purely subject existence occupies a larger space, and the feelings and ideas, being more attended to, are better known and remembered.

It is well known that when bodily vigour is high, and the disposition to exert it correspondingly great, self-consciousness in all its forms is at a low ebb. Advancing years, sickness, and confinement of the energies, throw the mind upon itself, and bring forth the points of introspective regard, in the shape of greater knowledge of the human feelings, more sympathy with others, a moralising tendency, and ethical self-examination.

Next to the disposition towards bodily energy, we must rank, as anti-subjective tendencies, the attractions for the sensations of the leading object senses, as Sight, Hearing, and Touch. A strong sensibility to colour, to form, to music, or to articulate utterance, operates in the direction of object regards;

if those sensibilities are only average, or below average, in a mind of great compass, a large share of attention will fall upon the subject states. We can never extinguish the object regards; they might even be too low for the purposes of mental study; the mind must exemplify its powers by working in the object attitude, in order that we may study these powers.

The subjective mind is more than usually alive to its *organic* states, which have very little object reference. These feelings direct us at most to the body itself, which is no doubt an object, as being a part of the extended; but, in contemplating it, we are not led out of self in the same decided manner as in viewing other objects. Indeed, by fixing the gaze on our own sensitive parts, we produce a new subject sensibility, owing to the associations that connect them so strongly with our feelings.*

BUSINESS, OR PRACTICAL LIFE.

73. In the higher departments of industry, or business—handicraft labour being the inferior department—the forces of the intelligence have a wide scope, the widest next to pure science. In the formalities and machinery of business,—book-keeping, calculation, money-reckoning, banking, contracts, deeds, acts of parliament, &c.—we have a number of dry artificial elements, not unlike the machinery of the ab-

* The tendencies of the mind towards sensation, or the actual, are opposed to two things, both included under one name, Reflection. A person may be given to Reflection, in the meaning of contemplation or meditation, in the matters of the object world. According to this meaning, every man of speculative thought must practice Reflection. It is by reflecting beforehand that we save ourselves the trouble of actual trials in many instances. The unreflecting and active temperament would prefer the trial. A mathematician, a physiologist, a politician, an engineer, a general, a poet, must reflect a great deal: having a certain acquaintance with the facts of the outer world, they must think over those facts in combining them anew for their several purposes.

The other meaning of Reflection is the introspective, or self-conscious regards, as now described. Sir W. Hamilton would call it the Presentative Faculty for the knowledge of self.

stract sciences, but touching more closely and frequently upon things of universal interest. In fact, the superior branches of industry,—in trade, manufactures, government, &c.—seem well adapted for the great majority of the cleverest minds. The pains averted, and the gratifications procured, by wealth, are so various and powerful, as to stimulate strongly the mass of human beings ; while only a very few can ever be possessed with the love of truth in the abstract, as a dominant sentiment of the mind.

74. The management of human beings, which is a large department of practical life, proceeds partly upon certain active qualities that give a natural influence and ascendency over others, and partly upon a knowledge of the ways and tempers of men. Without such knowlege in considerable measure, the master of workmen, the teacher, the legislator, and many other professions besides, can hardly be said to be skilled in their craft. It requires a kind of observation rendered difficult by the very causes that make man interesting to man ; for those passionate feelings that arrest our gaze upon our fellows, sway the mind from cool judgments. It is not so easy to read accurately a man or woman, as it is to read a mineral.

A person engaged in any work should naturally be alive to the *end*, for this it is that guides his hand. The builder sees that his wall is rising plumb and square. But it happens, somehow or other, that, in acting upon men in the various capacities of teaching, ruling, persuading, pleasing, serving, we are not so sensitive to the exact result of our attempts as in dealing with the material world, nor so easily made to modify the hand to suit the end in view.

ACQUISITIONS IN THE FINE ARTS.

75. In the Fine Arts, there are formed combinations, aggregates, groupings, rhapsodic successions,—such as to produce the species of effect termed beautiful, sublime, picturesque, harmonious, &c. ; and the perception of those effects is what we call Taste.

The artist in any department has to attain the power of producing these combinations. This power is, in the first instance, a result of creative spontaneity, guided by the sense of the effect produced; it is a mode of the natural forth-putting of the energies of the voice, or the hand, as in the commencement of every kind of active faculty. The first musician gave scope to his vocal powers at random, and gradually corrected the action according to his ear. When this natural outburst took some definite and agreeable shape, it became a song, a melody, caught up by imitation and handed down to future ages.

A large part of every artist's power necessarily comes by acquisition, or by the operation of the force of Contiguity. He stores up the combinations produced by previous artists, and fixes in his mind those that he produces in himself, and gradually rises to his highest efforts of execution. In this acquisitive process, the points of character that come to his aid, appear to be the following, of which, however, the enunciation is not new to the reader.

(1.) A keen sensibility and adhesiveness for the element or the *material* that the artist works in. The musician's ear must be sensitive to sounds and successions of sound, and that in the manner best adapted for fixing and retaining them: by which circumstance he is able to acquire a large stock of melodies. The sculptor must have a keen sense of contour and form; the painter, of form and colour; the actor, of dramatic movements; the poet, of language and the usual subjects of poetry.

(2.) In addition to this sensitiveness to the material of the art note in general, we must note the special sensibility to the *proper effects of the art;* the sense of melody and harmony in music, of beautiful curves and proportions in sculpture and architecture, of these and of coloured effects in painting, and so forth. I take for granted that beauty is not arbitrary,—that there are effects that please the generality of mankind when once produced. For these the Artist has a marked preference, and, by virtue of this preference, he acquires a stronger hold of what exemplifies them, than of what does not. It is not every mass of colouring that impresses itself on the painter's recollection. He ought to remember coloured masses in general better than other people, but being specially fascinated by a certain class which he calls harmonious, he is most ready to recall these at after times. So a poet needs a large disinterested adhesiveness for the concretes of nature and the incidents of humanity, but with this alone he would be indistinguishable from a born naturalist: the disinterested adhesiveness must be qualified by a special fascination for things that have a poet's interest, so as to alter the proportions of his impressibility, and give the preponderance to one special class of appearances. Not all trees, and all mountains, and all vegetation, and all displays of human feeling, should impress alike either a painter or a poet.

(3.) An artist in any art is to a great extent a *mechanical workman*, and progresses in his art according as mechanical operative skill fixes itself in its framework. The singer, the orator, the actor, owe their improvement to the retentiveness of the voice under vocal practice. The painter and sculptor must be persons that would soon learn any handicraft operation of the artisan's workshop. This muscular adhesiveness belongs to the structure of the muscular system with its nerve centres, and is a very material fact of character; it is the higher quality of the muscular development, mere brute force being the lower. It may be often observed, I think, that both qualities go together,—the plasticity and the physical force,—and with them, as a matter of course, an enjoyment and preference for muscular activity. An abstract thinker may dispense with this muscular element of character; but to the artist, in common with the artisan, the high physical development of the active organs I should consider an almost indispensable endowment. Its importance fades away only in such a case as the Poet, in whom the artist approaches to the man of pure thought and mere ideal activity.

HISTORY AND NARRATIVE.

76. The successions of events and transactions in human life, remembered and related, make History. A considerable

portion of each one's stock of recollections is made up of this kind of matter.

The transactions and events wherein we have been ourselves present, impress themselves on the mind as pictures of living men and women, their various manifestations, and the appearances and situations of things about them. It is thus that we retain the impression of a public assembly, a military spectacle, a pageant, a play, or any of the daily events of private society or of ordinary business. The pictorial mind is fully alive and susceptible to such things, and proves itself by retaining them. The retentiveness is influenced by the general interest in human beings, and by the specific or personal interest that belongs to the individual transactions. Of this last influence on the attention, it is easy to fall upon any amount of illustration. The soldierly feeling fixes the mind upon battles, reviews, and military movements; the trader is arrested by markets and trading enterprise; the politician by diplomatic congresses and debates; the sporting mind is alive on the race-course; the family interest excites the attention upon the incidents of the domestic circle.

A single transaction deliberately witnessed is often able to impress itself minutely on the memory for life. There seems to be, in the case of human events, an exception to the law of repetition, or to the usual necessity for passing a thing before the mind many times in order to make it coherent. But it is not difficult to account for this seeming anomaly. For, in the first place, such transactions are usually slow; that is, they keep the attention awake for a length of time before they are completed; a single race, if we include the preparations, will engage the mind for an hour together; while many transactions occupy days and months, being the subject of frequent attention all through. But, what is more, an event past is repeatedly brought up in the recollection, and every such occasion is a mental repetition. After being present at an exciting spectacle, our thoughts keep themselves engaged upon its details, and in the retrospect, we expand our attention upon things that were but hurriedly glanced at, as they passed before the actual view. Such rehearsal in the mind after the reality has passed, is a great means of impressing the events of our personal experience. The degree of emotional interest attaching to them displays its efficacy in bringing about their more or less frequent recall. What is indifferent passes away, and is never dwelt upon afterwards; what has excited us at the time excites us in the remembrance, and secures a large space in our ideal meditations. Provision is thus made for consolidating in the memory a train of circumstances that do not admit of being repeated in the view. We are enabled to recall, in after years, all the leading transactions that are now going on around us; we can describe the incidents connected with our family, our village, our city, our school, our places of business, recreation, or worship; we can live over again in minute detail, the scenes that had an intense pleasurable or painful interest at the time.

77. The transactions that we know by hearsay, or the narrative of others, impress themselves somewhat differently. We have no longer the actual scenes presented to our vision. They are represented by words, and the recollection is modified by the circumstances affecting verbal adhesion. If we make the extreme supposition, that the hearer of a narrative has his mind carried at once to the scenes and events themselves, and is able to realize them with an almost living reality, the case is not different from the foregoing; the words are made use of to hoist the scenes, and then drop away. But there are few people that have this vivid power of conceiving the realities of narrated transactions. In general, the verbal succession of the narrative is itself a medium of holding together the events contained in it, and the recollection is a mixture of adhesions, pictorial and verbal.

Written history may, therefore, be retained by a good verbal memory. Where the thread of pictured events has snapped, the thread of verbal succession in the printed page may chance to be adherent; between the two, the power of recollection on the whole is irregularly divided.

OUR PAST LIFE.

78. The train of our Past Existence, as a whole, is made coherent in the mind through contiguity, and can be recalled with more or less minuteness according to the strength of the adhesion. In any subject that is complicated with a multitude of details, only a few prominent features usually adhere; as, for example, the parts of a landscape, or the incidents of a history; and such is the case with the great complex current of each one's individual existence.

This current is made up of all the elements contained in the foregoing heads of this chapter. It is made up of all our actions, all our sensations, emotions, volitions, in the order of their occurrence. It is the track described by each individual through the world during his sojourn therein; it comprises all that he has done and all that he has been impressed with.

Under the previous head, I have spoken of the stream of history, or the current of events passing before the eyes of a spectator supposed to be passive. This spectatorship of what is going on about us, does not express the whole current of our remembered existence; there is wanting the series of our own doings and transactions. When what we have *done* is added to what we have *seen* and *felt*, the history of self is complete.

The peculiar feature of the present case, therefore, is the remembrance of our own actions according as they happened. We have to determine the nature of the bond that cements things done by us, and not simply seen.

79. In the first place, a vast number of our movements consist in changing the spectacle about us, or in producing a series of appearances to the eye, or effects on the senses in general. Thus when we walk out, we bring before our eyes a stream of houses, shops, streets, fields; and the impression of the walk, the coherent trace that it leaves in the brain, is, in part at least, pictorial, just as if we stood still and saw the scenes shifted in the same order. So, our work often consists in producing changes seen and remembered as sensible appear-

ances. The ploughman's active day is partly summed up in the furrowed field that is pictured in his mind in the evening retrospect. Hence it is that remembered actions may be to a great extent remembered appearances; and so far the case now in hand is in no ways different from the preceding.

It is evident, however, that there must be a remembrance of actions by themselves, as well as of the changes that they bring before the view. We do in fact have a recollection of our own active states as such; we can describe the movements made by us, the feelings of pleasant exercise, laborious exertion, or reposing fatigue, that we have successively gone through in a given day, week, or month.

This takes us back to what was advanced at the commencement of the present chapter on the Ideas of movement and action. I endeavoured to show that these are constituted by re-actuating the circles of movement, but so as to come short of the full stimulus required by the action itself; the remembrance of striking a blow is in reality all but to repeat the act, the restraining of the full display being sometimes a considerable effort. Now, successive actions cohere, both as actions and as ideas; we may either perform the actions outright, or stop short at the mere idea or vestige of the action. Much of our life is spent in going over remembered and ideal actions; and when we recover a work done by us, merely as a matter of history and not for the purpose of doing the work again, the vestige, or idea, of the different steps is what passes along the mental system. These vestiges of movements executed are as really and truly mental possessions, or ideas, as the remembered pictures of the external world through the eye. We can revive one or other in the ideal form; in truth, our recollections are usually a mixture of the two, inasmuch as our sensations are all unavoidably mixed up with movements.

Now in recalling a series of movements, as, for instance, a dance, simply for our own gratification, because of the agreeable feelings that they gave in the reality, we do nothing but revive those vestiges or diminished currents that suffice for the purpose of a recollection. This is to live our history over again in idea. But when we have acquired the power of *naming* all the various movements in the succession, the ideas, as they successively repossess the various organs, suggest the names of the different steps, and we can then narrate the whole in language. It is this power of narrating that we usually term the recollection of an event, and that constitutes history. With the power of language that belongs to human beings, it happens that our recollections of what we have gone through, do not occur as pure ideas of the actions and scenes themselves, but as ideas mixed up with verbal descriptions, which last are constantly disposed to intrude themselves into our recollections, even when these are not communicated to any one.

The firm adhesion of the ideas or vestiges of our active movements is a case of muscular contiguity, like the adhesion of the actions themselves in acquiring mechanical habits. I cannot find any other law for the association of ideas of movements than for actual movements. I have already endeavoured to discuss the circumstances favourable to the adhesion of muscular trains, and these would, I conceive, hold in the present case also. People that have a facility in acquiring mechanical habits, would have an equal facility in remembering the steps of any performance that they had gone through. The greater instance implies the less ; the adhesion of the movements in full, involves the adhesion of the currents that stop short of movement.

The case is altered, as above remarked, by the intrusion of language or expression ; in so far as we rely upon this, our remembrance will be easy or difficult according as our adhesiveness for language is strong or feeble. This is not the only instance of impressions retained by the help of some foreign machinery more adhesive than themselves. We have seen the same thing in the retention of the sensations of the inferior senses.

80. Our past life may, therefore, be conceived as a vast

stream of spectacle, action, feeling, volition, desire, intermingled and complicated in every way, and rendered adherent by its unbroken continuity. It is impossible to associate all the details, so as to recover them at pleasure; only the more impressive facts remain strung together in recollection. All the larger epochs and stirring incidents readily flow in upon our memory, when we go back to some early starting point; while the minor events fail to appear on the simple thread of sequence in time, and are recalled only by the presence of other circumstances that serve to link them with the present. It is our custom, in recalling the past, to string together events in new connexions, as when a person recites the history of his early education, selecting out of the miscellaneous stream the incidents that relate to this one point. Our individual history becomes thus broken up into sections and partial narratives; and to recover the total current, we should find it requisite to collect these into one great sequence, upon the thread of strict succession in order of time.

81. I have thus presented a series of examples of the working of the Retentive, or adhesive, property of the Intellect. As the subject proceeds, there will be other opportunities of adding to the illustration. The special branch of Moral acquisitions, or Habits, will best find a place in treating of Volition. There now only remain some general observations on the nature of this great adhesive force.

I would first remark the difficulty there is, in obtaining a measure of the absolute force of contiguous adhesiveness in an individual character. The modifying circumstances interfere so as to perplex the question. The endowments of the separate senses give a special retentiveness in each case; and the predilections for particular subjects, by determining the concentration of the mind, likewise produce great inequalities in our rate of acquiring different things. The only measure that we can propose for the general adhesiveness is the multitude, variety, and facility of acquisitions in general,—the ease of acquiring any kind of bent, habit, or faculty that may be entered on,—the distinction acquired as a *learner*, in all departments of knowledge, business, or art. We occasionally meet with characters of this description; the famous 'admirable Crichton,' as usually described, is an example of the highest order of the class.

In the second place, I may advert to the known superiority of early years as regards this force or plasticity. It is impossible to state with any precision the comparative intensity of the adhesive growth at different ages, but there can be no doubt of the fact of its gradual diminution from infancy to old age. Bodily acquisitions are easiest while the organs are still flexible, apart from the plastic adhesiveness of the brain; hence a maximum age is fixed for receiving recruits in the military service. At the present time, I believe the age of twenty-three is the extreme term of admission. Up to this age, any bodily habit is easily assumed; the moral discipline of obedience is also comparatively easy. But for both the one and the other, the earliest years are the best. Then we must always take account of the obstruction arising from adverse bents and acquisitions. In matters where the bodily and mental system are not in any way pre-occupied, the age of twenty-five is a very plastic age, as, for example, in learning business-forms, languages, or science. On the other hand, the voluntary command of the attention is greatest in mature life, a circumstance very much in favour of acquisition.

I remark, finally, that there is a temporary adhesiveness as distinguished from what is enduring or permanent. I can convey a lengthy message from one room to another, but am unable to reproduce it next day. The endurance of the first impression, while the mind is wholly occupied with it, is no surety for its being retained for a week or a month to come.

The illustration in this chapter has been mainly directed upon the enduring acquisitions. We have generally understood the retainability of an impression to mean the power of recalling it at any future time, however remote. But it is necessary to take account of the tendency of all acquisitions to decay by time; the rate of decay being dependent on various circumstances, and chiefly on the decay of the brain itself. It is observed that the impressions that survive, in extreme old age, are those of early years.

To keep our acquisitions from decaying, it is requisite that they should be occasionally revived. A language acquired in early years may be utterly lost by disuse; if kept up till mature age, it will be fixed for life. Sustained practice seems particulary necessary in early education: children's acquisitions are very liable to decompose, if not kept up and confirmed by new additions. No precise laws have ever been ascertained in this department of the human mind.

The system of *cramming* is a scheme for making temporary acquisitions, regardless of the endurance of them. Excitable brains, that can command a very great concentration of force upon a subject, will be proportionably impressed for the time being. By drawing upon the strength of the future, we are able to fix temporarily a great variety of impressions, during the exaltation of cerebral power that the excitement gives. The occasion past, the brain must lie idle for a corresponding length of time, while a portion of the excited impressions will gradually perish away. This system is unfavourable to permanent acquisitions; for these, the force of the brain should be carefully husbanded and temperately drawn upon. Every period of undue excitement and feverish susceptibility, is fraught with great waste of the plastic energy of the mind on the whole.

CHAPTER II.

AGREEMENT—LAW OF SIMILARITY.

Present Actions, Sensations, Thoughts, or Emotions, tend to revive their LIKE among *previous* Impressions, or States.

1. CONTIGUITY joins together things that occur together, or that are, by any circumstance, presented to the mind at *the same time* as when we associate heat with light, a falling body with a concussion. But, in addition to this link of reproductive connexion, we find that one thing will, by virtue of similarity, recall another separated from it in time, as when a portrait recalls the original.

The second fundamental property of Intellect, termed Consciousness of Agreement, or Similarity, is a great power of mental reproduction, or a means of recovering past mental states. It was recognized by Aristotle as one of the links in the succession of our thoughts.

As connected with our Knowledge, or perception, of things, the consciousness of Agreement, is second only to Discrimination, or the consciousness of Difference. When we know a thing, we do so by its differences and its agreements. Our full knowledge of red, is our having contrasted it with all other colours, and our having compared it, with itself and with its various shades. Our knowledge of a chair is made up of our experiences of the distinction between it and other articles of furniture, &c., and of the agreement between it and other chairs. Both modes are involved in a complete act of cognition, and nothing else is necessary. Our knowledge of man is the sum of the points of contrast between a man and all other things, and the sum of the points of identity on comparing men with one another. Our increase in knowledge is constantly proceeding in both directions: we note new differences and also new agreements, among our object, and among our subject, experiences. We do not begin to be conscious till we have the shock of difference; and we cannot make that analysis of our conscious states, called the recognition of plurality, combination, or complication, till we discover agreements, and refer each part of the impression to its like among our previous impressions. To perceive, is to recognise, or identify.

2. Some preliminary explanation of the kind of relation subsisting between the two principles of Contiguity and Similarity, is requisite in order to guard against mistakes, and especially to prevent misapprehension, as to the separate existence of the two modes of action in the mental framework. When the cohesive link between any two contiguous actions or images, is confirmed by a new occurrence or repetition, it is obvious that the present impression must revive the sum total of the past impressions, or reinstate the whole mental condition left on the occasion immediately preceding. Thus, if I am disciplining myself in the act of drawing a round figure with my hand, any one present effort must recall the state of the muscular and nervous action, or the precise bent acquired at the end of the previous effort, while that effort had to reinstate the condition at the end of the one preceding, and so on. It is only in this way that repetition can be of any avail in confirming a physical habit, or in forming an intellectual aggregate. But this reinstatement of a former condition by a present act of the same kind, is really and truly a case of the operation of the associating principle of similarity, or of like recalling like; and we here plainly see, that without such recall, the adhesion of contiguous things would be impossible. Hence it would appear, that all through the exposition of Contiguity, the principle of Similarity has been tacitly assumed; we have always taken for granted, that the recurrence of any object to the view, recalled the total

impression made by all the previous occurrences, and added its own effect to that total.

But, by thus tacitly assuming the power of anything present to reinstate the past impressions of the same thing, we restrict ourselves to those cases where the reinstatement is sure and certain, in fact to cases of absolute identity of the present and past. Such is the nature of the instances dwelt upon in the previous chapter: in all of them, the new action, or the new image, was supposed precisely identical with the old, and went simply to reinstate and deepen an impression already made. We must, however, now pass beyond this class of examples, and enter upon a new class where the identity is only partial, and is on that account liable to be missed; where the restoration, instead of being sure, is doubtful; and where, moreover, the reinstatement serves higher purposes, than the mere iteration and deepening of the impression already made. In all mental restorations whatsoever, both Contiguity and Similarity are at work; in one class, the question is as to the sufficiency of the contiguous bond, the similarity being sure; in another class, the question is as to the sufficiency of the attractive force of the likeness, the contiguous adhesiveness being believed secure. If I chance to meet with a person I have formerly seen, and endeavour to remember his name, it will depend upon the goodness of a cohesive link whether or not I succeed; there will be no difficulty in my recalling the past impression of his personal appearance through the force of the present impression; but having recalled the full total of the past impressions, I may not be able to recover the *accompaniment* of the name; the contiguity may be at fault, although the similarity works its perfect work of restoring to me my previous conception of the personal aspect. If, on the other hand, I see a man on the street, and if I have formerly seen a portrait of that man, it is a question whether the living reality shall recall by portrait; the doubt hangs not upon the contiguity, or coherence of the parts of the picture, if it could be recovered, but upon the chance of its being recovered. Where things are identical, the operation of similarity in making the present case revive the former ones is so certain, that it is not even mentioned; we talk of the goodness of the cohesive bond between the revived part and its accompaniments, as if contiguity expressed the whole fact of the restoration. To make up for this partiality of view, which was indispensable to a clear exposition, we now embrace, with the like partial and prominent consideration, the element that was left in a tacit condition, and allow to sink, into the like tacit state, the one that has hitherto been made exclusively prominent.*

3. In the case of perfect identity between a present and a past impression, the past is recovered and fused with the present, instantaneously and surely. So quick and unfaltering is the process that we lose sight of it altogether; we are scarcely made aware of the existence of an associating link of similarity in the chain of sequence. When I look at the full moon, I am instantly impressed with the state arising from all my former impressions of her disc added together; so natural and necessary does this restoration seem, that we rarely reflect on the principle implied in it, namely the power of the new stimulus to set a going the nervous currents, with all the energy acquired in the course of many hundred repetitions of the same visual impetus. But when we pass from perfect to imperfect or partial identity, we are more readily made aware of the existence of this link of attraction between similars, for we find that the restoration sometimes does not take place; cases occur where we fail to be struck with a similitude; the spark does not pass between the new currents and the old dormant ones. The failure in reinstating the old condition by virtue of the present stimulus, is, in the main, ascribable to imperfect identity. When, in some new impression of a thing, the original form is muffled, obscured, distorted, disguised, or in any way altered, it is just a chance if

* To a mathematical student this would be made at once intelligible by saying that, in the former chapter, the Contiguity is assumed as the *variable* element, and the Similarity the *constant;* in this chapter, Similarity is supposed variable and Contiguity constant.

we recognise it; the amount of likeness that is left will have a reviving power, or a certain amount of reinstating energy, while the points of difference or unlikeness will act in resisting the supervention of the old state, and will tend to revive objects like themselves. If I hear a musical air that I have been accustomed to, the new impression revives the old as a matter of course; but if the air is played with complex harmonies and accompaniments, it is possible that the effect of these additions may be to check my recognition of the piece; the unlike circumstances may repel the reinstatement of the old experience more powerfully than the remaining likeness attracts it; and I may find in it no identity whatever with an air previously known, or I may identify it with something altogether different. If my hold of the essential character of the melody is but feeble, and if I am stunned and confounded with the new accompaniments, there is every likelihood that I shall not experience the restoration of my past hearing of the air intended, and consequently I shall not identify the performance.

4. The obstructives that prevent the revival of the past through similitude, may be classed under the two heads of Faintness and Diversity. There are cases where a new impression is too feeble, to strike into the old-established track of the same impression, and to make it alive again; as when we are unable to identify the taste of a very weak solution, or to recognise an object in twilight dimness. The most numerous and interesting cases come under the other head of Diversity, or mingled likeness and unlikeness; as when we meet an old acquaintance in a new dress, or in circumstances where we have never seen the same person before. The modes of this diversity are countless and incapable of being classified. We might indeed, include under diversity the other of the two heads, seeing that faintness implies diversity of *degree*, if not of any other circumstance; but I prefer considering the obstruction arising from faintness by itself, after which we shall proceed to the larger field of instances constituted by unlikeness in other respects.

5. The difficulty or facility of resuming a past mental condition, at the suggestion of a present similitude, will depend in part upon the *hold* that the past impression has acquired; it is much easier to revive a familiar image than an unfamiliar, by the force of a new presentation. We shall, therefore, have to keep this circumstance in view, among others, in the course of our illustration of the law of similarity.

It has to be considered how far natural character, that is, a primitive endowment of the intellect, enters into the power of reviving similars, or of bringing together like things in spite of the repulsion of unlike accompaniments. There is much to be explained in the preferences shown by different minds, in the objects that they most readily recall to the present view; which preferences determine varieties of character, such as the scientific and artistic minds. The explanation of these differences was carried up to a certain point under the Law of Contiguity; but, if I am not mistaken, there is still a residue referable to the existence of various modes and degrees of susceptibility to the force of Similarity. From all that I have been able to observe, the two energies of contiguous adhesion, and of attraction of similars, do not rise and fall together in the character; we may have one feeble and the other strong, in all proportions and degrees of adjustment. I believe, moreover, that there is such a thing as an energetic power of recognising similarity in general, and that this is productive of remarkable consequences. Whether I shall be able to impress these convictions upon my readers, will depend upon the success of the detailed exposition of this leading peculiarity of our intellectual nature.

FEEBLENESS OF IMPRESSION.

6. We commence with the case of Faintness, or Feebleness, in the present, or suggesting impression, considered as an obstacle to the revival of the corresponding previous impression. There is, in every instance, a certain degree of feebleness that will disable the present image from falling into the track worn by the same image in its former advent. When

an extremely faint suggestion, in the present, answers completely the purpose of reviving the old currents, we must consider that the restoring action of similarity is unusually vigorous in that mind, or for that class of impressions. Thus if, from a very feeble solution of salt in water, such as occurs in many land springs, the impression on the tongue were sufficient to revive in one person, and not in another, the past state of mind produced by the tasting of salt, we should naturally remark that, in the one, the attraction of similars in the matter of taste is more vigorous, than in the other. Doubtless there is another circumstance that would make a difference, without any positive distinction in the character of the intellectual force of similarity; that is, the familiarity with the substance tasted, combined with a habit of attending to minute differences, in other words, a concentration of the mind upon the effect; but where this difference, due to professional habits, does not exist, the only interpretation we can put upon the circumstance is that now supposed,—an inequality in the power of reinstating a past condition of mind by a similar one present. If, without any express education, one person can discern common salt in a solution when present at the rate of eight grains to the gallon, while another person requires twelve grains per gallon to be present, and a third twenty, then these numbers would roughly express the strength of the force of similarity on the matter of Taste, in the three persons respectively. We cannot infer from this that in other impressions, as in Smell or Hearing, there would be the same distinction in these three parties, inasmuch as the character of the special organ counts for something. The structure of the tongue may be such as to make a slight taste, in one person, as impressive as a stronger taste in another person: while, in order to ascribe the difference to the general intensity of the attraction of similars, we should have to suppose the same solution to yield an equal sensation, or an equal intensity of the feeling of taste in both cases.

7. Such is an example taken at random, to show what is meant by the revival of impressions under the impediment

that feebleness puts in the way. I might go systematically through the Sensations of the various Senses, to gather illustrations of the same fact. (Movements apart from Sensations do not furnish cases in point). In the various sensations of Organic Life, there occur examples of difficult reinstatement, through feebleness of the suggesting sensation. I may experience a certain uneasy sensation, which I cannot describe or recognise, because of its being too faintly marked to reproduce the old accustomed impression of the same thing. It may be a derangement of the stomach, or the liver, or the brain, such as I have experienced before and possess a durable conception of; but being too little prominent to strike into the old track it reminds me of nothing, and I cannot tell what it is. By and bye it increases somewhat, and becomes powerful enough to reinstate some likeness of it in the past, and I then recognize it. If, on the one hand, the feeling is located in an organic tissue, easily inflamed into sensibility by a light impression, or if, on the other, the general power of similarity is comparatively strong, and the recognition of organic pains and pleasures rapid and easy, a very slight manifestation makes me at once aware of what is happening to me. This keen organic sensibility may be noted as a peculiarity of some constitutions, making the individual extremely self-conscious, in the sense of being alive to every passing change of organic state; generating hypochondria and the alternation of fears and hopes regarding one's bodily welfare. The peculiarity will be occasionally found rising to a morbid extreme; as when the individual never passes an hour without solicitude on the matter of health and mortality. Obtuseness of feeling to what is going on within the various bodily parts is a defect fraught with dangerous neglect; while, on the other hand, a needless amount of distress, and a needless waste of precaution, may be the result of too much sensibility, whether this have its origin in the sense or in the intellect.

8. I have already cited an example from Taste. There would be no material difference in the circumstances of a case of Smell. When a very faint odour is recognised or identified,

this shows that, notwithstanding the faintness of the impression, the previous sum total of the same smell has been brought back. If two persons be subjected to the same odour, as in walking through a garden, and if one recognises it while the other feels it not, the difference is to be referred to one or more of the three main circumstances involved in such a perception,—namely, greater familiarity with the odorous substance, greater acuteness of the organ, or greater force of the attraction of similars. If both parties are known to be alike familiar with the supposed odour, we must refer the difference to one of the two remaining circumstances; and if, by some further test, we could find that they had equal delicacy of organ; that is, if it could be shown that the same smell caused a nearly equal force of sensation or consciousness, the explanation would be thrown upon the last of the three considerations, the intellectual force of similarity, which we are now bent upon tracing out. If a person is not remarkable for being excited, agitated, in other words made highly sensitive, by strong odours, while yet able to identify those that are feeble, we must ascribe to such a person a large development of the power of similarity; for, if the identification were due to the easy inflammability of the membrane of the nose, we should find that a very great excitement would be produced when the action was strong. The experiment to decide between sense and intellect, as the principal agent of the identifying faculty, might be made thus. Expose two persons to a strong repulsive smell, assafœtida for example. Ascertain by their manner of excitement and by their expression of their feelings, whether it affects them equally, or nearly so. We cannot expect to determine this point with very great nicety, but in a rude way the thing is possible. Suppose we find that they are almost equally affected by the odour, or, have a nearly equal degree of repulsive sensation. Let this experiment pass over for some time, and subject the same persons to an extremely faint exhalation of the same substance. Let it be so faint at first as to be imperceptible, and raise it by very slow degrees, until one of the two is struck with the idea that assafœtida is present. If the one notices it a considerable time before the other has been affected to the same point, the two must differ in the general power of reinstating like by like, or in the attraction of similars; that is, we must attribute the superior smelling acuteness of the one to something different from the susceptibility of the sentient surface, which has been put to the test and found equal in both.

9. The sense of Touch does not appear to furnish any instructive case of the action of reinstatement made difficult by feebleness of impression, for we can usually command any degree of contact that we please. We may, however, derive examples in point from Hearing. It often happens that sounds are so faint as to be barely recognizable, in which case we shall observe one person making them out and another missing them. The difference of acuteness must be referred as before to familiarity, to delicacy of ear, or to facility of reinstatement, one or other. The influence of familiarity, the first of the three causes, is well exemplified in sounds. Compare the hearing of our mother tongue with the hearing of a foreign tongue; every one knows how easy it is to catch up an utterance in the one, even when very faintly pronounced, and how utterly we fail in the other under like circumstances. The same contrast is observed between a familiar voice and the voice of a stranger; persons partially deaf identify the speech of those about them, while others to be as easily understood must raise their voice to a much higher pitch. This fact as to the greater readiness of reviving a deeply printed impression, obtains all through the field of associations by similarity; the readiness follows the growth of the adhesive bond of contiguity under repeated conjunctions of the associated things. The more thoroughly accustomed the mental system is to an impression, the lighter the touch needed to make it present at any moment.

10. The same line of illustration can be carried out under the Sense of Sight. There is a point of twilight dimness when objects begin to be doubtful; they fail to reinstate the corres-

ponding previous impressions whereby their identity is made apparent. Haziness in the intervening sky, and mere distance, have the same effect. In those circumstances, we find that an object can be identified by one person, and not by others equally well situated for discerning it. Familiarity may be the main cause of the difference, as when a sailor identifies a speck in the horizon as a ship of particular build. If not attributable to this cause, the superiority of one person over another in discernment must be ascribed to one or other of the remaining causes, namely, the sensitiveness of the eye, or the force of similarity. If by any appropriate test, such as the one above described for smell, we could prove the eyes of two persons to be equally impressible to degrees of light, the difference of discernment would fall to be attributed to a difference in the force of reinstatement of like by like.

11. In the case of very exalted acuteness of sense, such as we witness among the Indians, who can discern the tread of horses at a great distance by applying the ear to the ground, and who have also a high degree of long-sightedness, we must refer principally to the first of the above-named circumstances for the explanation, that is, to familiarity, or education. It may be that a hereditary acuteness of sense becomes developed in that state of life, but practice is undoubtedly the main cause of the remarkable difference in this respect between these savage tribes and the generality of mankind. For we are to remark, that their education is not simply a frequent repetition of those sensations of the tramp of horses or mén on the ear, but the concentration of the brain upon the sense on those occasions, whereby an intense stretch of attention habitually accompanies the act of listening. A sense can always be developed to a high degree, by an intent application of the entire force of the brain to its sensations. The degree of voluntary attention given to an observation of sense, will at any time make the sensation more acute ; a habit of absorbing attention will generate a permanent acuteness at the expense of attention to other things. A painter will be the more impressed with a landscape that he is deaf to the song

of birds, the hum of insects, or the murmur of the breeze; the whole soul, passing into one sense, aggrandizes that sense and starves the rest.

12. The acuteness of the senses in animals may in like manner be accounted for. The scent of the dog resolves itself into the identification of an exceedingly faint impression. An effluvium on the nostrils of a pointer, revives the former impression of the smell of a hare, while on the human nose the same effluvium is utterly devoid of effect. Here we must attribute the distinction neither to education nor to the force of the association of similarity, but to the acuteness of the smelling organ. Any given smell will produce a far more intense sensation in a dog than in a man. If we take a scent sufficiently strong to be felt by both, as when the hare is brought close enough to be felt as a smell on the human nose, the man is calm in his manifestations, whereas the dog is excited almost to madness. By this we can see, that such is the organization of the smelling organ of the dog, that impressions made on it are transmitted to the brain in a highly magnified state; and further, it may be, that the brain is specially inflammable to a particular class of sensations of smell, an effect to which nothing corresponding is found in the human constitution. Even if the smell of a hare were multiplied a thousand times in the human nose, and made equal to the impression made on the brain in the dog, it would not follow that the same maddening excitement would follow; this is an additional circumstance growing out of the emotional nature of the animal, or out of the deep-seated circles of its brain.

The far-sightedness of birds depends in part on the adaptation of their eyes to distant vision. It corresponds with the far-sightedness of persons habituated to remote objects, or to the change that age makes in the lenses of the human eye. We have had occasion to notice the superior development of the adapting muscles of the eye in birds, whereby the organ can go through a greater range of adjustment than is in the power of other animals.

There thus appear to be but few cases, where we can decisively attribute acuteness in identifying objects, under feeble impressions, to the purely intellectual part of the process, the reinstatement of the old by the new through the force of likeness. This intellectual peculiarity is by no means prominently illustrated by this class of examples; still it is proper for us to allude to them as unquestionably involving the operation of the principle.

SIMILARITY IN DIVERSITY.—SENSATIONS.

13. We now approach the case that contains the greatest amount of interesting applications—the case of similarity disguised by mixture with foreign elements, the Like in the midst of the Unlike. There is often very great difficulty in recognising an old familiar object owing to alterations that have been made upon it. Coming back after a lapse of years to a place that we had lived in, we find houses and streets and fields and persons so altered that we fail to identify them; the differences that have overgrown the permanent features are, in many cases, such as to destroy their power of reinstating the ancient impressions. When likeness is thus surrounded with diversity, it is a doubtful point whether the attraction of similars will succeed in reviving the old by means of the new. In these cases of doubtful and difficult reinstatement, we come to observe great differences in the intellectual reach of individuals; out of a number of persons placed in a similar predicament, some will be struck with the likeness; the flash of identity will come over them, and the past will stand side by side with its muffled likeness in the present; others again will see no identity, the attraction of the new for the old will, in them, be overborne and quenched by the surrounding diversity.

To trace the workings of the attractive force of similarity in its struggles with the obstruction of unlike accompaniments, I count one of the most interesting problems of the human mind; and I trust that, in the course of the illustration that is to occupy the remainder of the present chapter, my readers will grow to be of the same opinion. Although any natural defect in this link of reproduction is perhaps less capable of being made up by artificial means than in the case of contiguity, yet we shall see that here too there are circumstances, under our control, that have an undoubted efficacy in clearing the way for the reviving stroke of similarity.

14. Before proceeding to the main subject under the present head, namely, the Sensations, I shall advert to the one case of Action, or Movement, that furnishes interesting examples of the working of the present law, I mean articulate action, or Speech. In the numerous and various trains of articulation entering into our education in language, there are many instances of recurring likeness in the midst of unlikeness, leading to the revival of the past by the present. We are constantly liable to be reminded of past sayings of our own and of other people, and passages of writings that we have read, by hitting on catch-words or identical phrases, at a time when our thoughts are running in some quite different channel. The single word 'phrenzy' uttered with emphasis will recall, in a mind familiar with the passage, 'The poet's eye in a fine phrenzy rolling;' the principal epithet in such a case being enough to reinstate the entire connected train. Through the suggestion of common words, we can thus leap from one passage to another, by the remotest fetches, in an endless succession of recollections. The character of the mind will determine the prevailing character of the revived sayings; in one mind, they will be poetical and ornate; in another, prose melody will have the preference; in a third, epigram and wit; in a fourth, sententious wisdom and prudential saws. The sayings and passages that have been impressed upon us, in the course of our education, will come up through the medium of common phrases; and the general power of similarity in the mind, modified by the quality of the articulate sensibility in particular, will determine the abundance of this class of revivals, in other words, the quantity of speech flowing into the utterance of the individual. The force of Con-

tiguity strings together in the mind words that have been uttered together; the force of similarity brings forward recollections from different times and circumstances and connexions, and makes a new train out of many old ones. I may have learnt, at one time, a passage from Milton, at another, an extract from Pope, on a third occasion, a piece from Campbell; mere contiguity would enable me when reminded of the commencing words of any of these passages to repeat the whole; but the energetic working of similarity would enable me to break into any one or all of them, while speaking on some remote subject. I chance to fall into two or three words resembling an expression in one of the pieces, and notwithstanding the diversity of the context, the old stream of recollection is re-constituted, and the entire passage brought within my command. The attraction of sameness is here manifested as overcoming the repulsion of diversity. I am uttering a connected series of words, and among these, one, two, or three, have by chance the echo of one of the falls of an old utterance; instantly I feel myself plunged in the entire current of the past, and may avail myself of any portion of it to serve my present end in speaking. Neither the unlikeness of the context, nor the totally foreign nature of the subject matter, will stifle the reviving action in a mind very much alive to articulate effects, although both have a share in resisting the stroke of resuscitation. I assume that there is in each mind a special degree of the attraction of similarity for articulate utterances, just as there is a special degree of contiguous adhesiveness; and both have their measure, although in different ways. The adhesiveness is measured by the fewness of repetitions necessary to fix a connected speech in the memory; the other is measured by the amount of repulsion and disparity that can be overcome, in bringing an old train forward by the force of a new one.

Unlikeness of circumstances and situations is no bar to the revival of past expressions, any more than difference of verbal context and subject matter. A word casually spoken in some present emergency, will often revive a stream of recollections and incidents long past, where that word chanced to figure as an important turning point of the history. It is hardly possible to fall into the phrase 'every man to do his duty,' without being put on the track of our recollection of Nelson's last victory. The word 'duty' is liable at any time to bring up the Duke of Wellington. These verbal coincidences are one great link of connexion between us and our past experiences ; they put us ever and anon upon the track of some bygone incident of our history. And the more alive we are to the influence of words, the larger is the share of reviving efficacy that belongs to them.

The hold that we have of language, not being confined to the articulate organs, but extending over the senses of hearing and sight, and being besides influenced by the emotions, we shall have to recur to the topic on various occasions. The importance of language in the operations of intellect generally, justifies a frequent reference to the subject.

15. To pass to the Sensations. In Organic Life, there are many cases of a sensation repeated with new admixtures, serving to disguise its character, and to prevent its recalling the former instances of the same impressions. It often happens that the same organic state is produced by very different causes. A shock of grief, a glut of pleasure, a fit of overworking, an accidental loss of two or three nights' rest, may all end in the very same kind of headache, stupor, or feeling of discomfort ; but the great difference in the antecedents may prevent our identifying the occasions. The derangement caused by grief is more likely to recall a previous occasion of a similar grief, than to suggest a time of overdone enjoyment ; the sameness in organic state is, in the case of such a parallel, nullified by the repulsion of opposites in the accompanying circumstances ; a state of grief does not permit a time of pleasure to be recalled and dwelt upon ; the loss of a parent at home is not compatible with the remembrance of a long night of gaiety abroad. Hence we do not identify the supposed state of organic depression with all the previous recurrences of the same state ; unless, indeed, a scientific education

has made us aware of the sameness of the physical effects resulting from the most dissimilar causes.

16. Under Taste, we have examples of a like nature. A taste may be so disguised by mixture as to be undiscernible; the presence of the other ingredients operating to resist the reviving power of the one that we desire to identify. In a solution of Epsom salts we should not be able to discern a small quantity of sugar. The saline bitter of the salts acts upon the tongue and the sense, so as to render it impossible that the sugary taste should have any influence. This is an example of the weak borne down by the powerful. Again, when malt liquor becomes sour, we are unable to discriminate any longer the alcoholic taste, the action of the acid on the palate overwhelms every other sensation. If, in such a case, the alcohol is still discernible by any one person, when others fail to perceive it, we should say that the power of reinstatement for alcohol was strong in such a one's mind, either from old familiarity or a great susceptibility to this particular impression, or from the more deep-seated cause of a vigorous attraction of similars of every description.

17. Hitherto I have spoken of sensations identified through actual sameness, the identification being impeded only by others mixed up with them. A case of greater complicacy and more importance is furnished by the existence of sensations really different, but having something in common. Take as an instance the tastes of the various wines; these are all different, and if similarity acted only in absolute sameness, port would remind us only of port, claret of claret, madeira of madeira, and so on. But we find that there is so much of a common influence in all wines, that any one of them can remind us of a great many others; we, at the same time, noting points of difference, when they are thus brought into comparison. It is this common influence, with its suggesting power, that has led mankind to constitute what is termed a class, or a genus, 'wine,' comprehending many widely scattered individuals. The identification of likeness in the midst of unlikeness, in other words, of a common property, is the

essence of this classifying operation. A *class* differs from a catalogue by virtue of a common resemblance in the midst of diversity. Farther, this class, 'wines,' identified through their common organic sensation and taste, is merged in a larger class when spirituous liquors come to be known. There is felt to be an identity between the principal effect of these liquors on the system, and the effect of the various members of the vinous group. The class is now extended; although, because of there being some features common to wines that do not attach to spirits, these are still held together in a group by themselves, subordinate to the larger group, or as a species coming under the other as a genus. The addition of malt liquors to the comparison extends the identity still farther and enlarges the class of substances that suggest one another by virtue of the common quality of causing intoxication. These malt liquors being themselves identical in more points than those common to them with wines and distilled spirits, they also make a small species by themselves contained in the comprehensive genus of intoxicating drinks.

It was not discovered at first that this influence, common to so many substances derived from such various natural sources (the grape, the sugar-cane, barley, oats, rice, &c.), was due to one distinct ingredient occurring in them all under various combinations. The identification had proceeded solely on their common influence on the human system, and not from discerning the recurrence of the common element, alcohol. Had the grouping proceeded on this perception, the case would have been exactly like those above described, where a taste or smell is identified in its mixtures with other tastes or smells. But the substances were classed together, without men knowing whether it was that many different liquids had the same action on the human body, or that there was one substance that pervaded many compounds, to which the influence was solely owing. It was a generalization of a common internal feeling, not of a common external object.

Another example akin to the foregoing is furnished by the pungent odours. The influence of the various kinds of snuff upon the nose is so well marked, that we readily identify it notwithstanding differences of aroma or flavour. Upon this similarity, we group all the different varieties together, and make a class of bodies, any one of which may be used for any other when the common effect of pungency is desired. The kinds of snuff would doubtless also be identified on the ground of their common origin, the tobacco plant, like wines by the grape. But looking at the subjective sensation of the snuffs, we find that this assimilates itself to a like sensation produced from other bodies ; thus the odour of smelling salts may by similarity recall the odour of snuff, and the two different substances will in this way come together in the mind. If we have at any time acquired the impression of hartshorn, this impression also might be recalled in virtue of its resemblance to these others ; we should than have three distinct experiences brought up from different times and circumstances of our past history to the present view, these experiences presenting three different substances lying quite remote from one another in nature, but now drawn together in the mind, from exerting on it a common influence. If our acquaintance with pungent odours had been still greater, others would be recalled to join the group already formed, and we should have amassed, from far or near, a multitude of recollections strung upon one common thread of resemblance, and these recollections would thenceforth be held together as a group in the mind, forming what we term a class, a genus, or a generalization of agreeing objects.

In this instance, there is no external element common to all the bodies producing the pungent effect ; the classification is based purely on the common sensation of smell. The smelling salts and hartshorn are identical, inasmuch as both yield ammonia ; but the effluvium of snuff is not ammonia, although found to bear a resemblance to it in chemical constitution.

These various identifications put to the test the force of similarity in different individuals. While seized by some minds, they are wholly missed by others; and the reason for their being missed usually resolves itself into one or other of the defects already recounted;—the obscuration of the differing ingredients in the combination, the want of good previous impressions, obtuseness of the sense itself, or feebleness in the action of similarity generally. Possibly, also, the attention may never be turned upon the subject. A distinct effort made to recall some past object resembling a present one has a chance to succeed, when without such effort the identity would never flash on the mind.

The greater the diversity that muffles up a likeness, the greater the intellectual stretch requisite in reinstating the past on the mere force of likeness; the former impressions must be good, or the sense delicate, or else the recalling stroke of similarity in general vigorous, in order to succeed in a case where the discrepancy is so strong, as nearly to overwhelm the agreement.

18. The illustration of Similarity in Touch might be very copious. I prefer, however, to reserve the largest share of our space for the two highest senses.

The intellectual sensations of Touch may be said to start from the feeling of a Plurality of points; this, combined with Movement, gives the sense of surface both as to quality and as to size and shape. On all possible varieties of surface, we may have identification at work. Thus, if I take in my hand a wooden ball, the positions given to my fingers in handling it, reinstate the old engrained impression of the round shape got from the various balls that I have handled in my time. The feeling of the surface may also revive the impression of other surfaces not globular; the impression belonging to the material—whether fir, oak, beech, mahogany, &c. The shape is not a sufficiently powerful disguise, to prevent my identifying the substance with my former recollections of the same timber in many different shapes. A blind person accustomed to discriminate by touch what others discriminate by sight, would not be distracted by altered form; he might be distracted by differences of polish; the remaining similarity, in that case, being too faint to waken up the former impressions of the same material.

We can generally identify any substance touched, as being wood, stone, metal, wool, silk, cotton, linen, &c. Under very considerable differences of form and fabric, these characteristic kinds of material can still be discerned by the force of similarity. In cases where one sort approaches very closely to another, as in the approximation of cotton to woollen cloth, we have those difficult and testing examples where one person will succeed, and another fail, in detecting the true resemblance. So in the viscid and powdery substances that come under the hands of the dyer, painter, potter, baker, cook, &c., there are cases of easy, and of difficult, identity of touch; variations occasionally happen such as to blind the sense of identity. It is when a very small trace of likeness is sufficient to restore the past impression of the material, and with it the former experience as to its character, that the practised hand and the acute sense manifest their power. The feeling to the touch is included among the qualities of Minerals.

19. To take next the sense of Hearing. The analysis of sounds has shown us the complexity of the characters attaching to any one individual sound, and to what extent identity in some of these may be disguised by differences in others. For example, the *pitch* of a note may be readily identified when sounded on some voice or instrument familiar to us; but, on a strange instrument, it is less easy to make out the identity. The change of quality in the note, the greater or less emphasis, the different duration of the sound, as in comparing a piano note with an organ, all tend to disguise the pitch, and to render a more delicate or a more cultivated ear necessary for its discernment. Any natural obtuseness of sensibility to the attribute of pitch will be demonstrated by such a trial as this; for if the same note be played feebly on the violin and thundered on the organ, the great disparity of emphasis will confound the ear, and destroy the sense of what is common to the two. We have already seen that the delicate appreciation of pitch is the foremost requisite of the

musical ear; being a point of character that a musical education tends to improve. When thoroughly cultivated, the ear is able to identify every note on the scale, however sounded; no distracting accompaniment ought to be able to disguise this, which is the first attribute of a sound, as regards musical composition.

The property of *articulateness* of sound is very apt to be disguised beyond the reach of identity by strange accompaniments. Our ear for articulation is formed in the first instance on the voices around us; we identify with ease a letter or a word as pronounced by those; in fact the casual peculiarities of their manner become, as it were fused, with our sense of the articulations themselves. A child born in Yorkshire acquires an ear for the vowels and consonants of the alphabet as sounded in Yorkshire. If we pass into Middlesex, the articulations correspond without being identical; and it puts a considerable strain upon the force of reinstatement to identify the old words under the new utterance. Such an experiment would show whether the ear is good as respects the essential quality of articulate form, just as the trials above alluded to show the degree of delicacy as regards the pitch of a note. Some ears are but faintly susceptible to the distinctiveness of the articulations, or to the essential difference between one vowel and another, and between one consonant and those closely allied to it. If such ears happen to be acutely sensible to the qualities of different voices, and to differences of emphasis, or stress, they will be more strongly acted on by the disagreements than by the agreements.

The illustration takes a wider sweep, when we suppose a continuous flow of a sound, as in a musical performance or a consecutive address. The effects on the ear being more varied, there is greater scope for tracing similarities, and more opportunity for the obstruction arising from diversity. We can commonly identify an air that we have once known, on all varieties of instruments, and with or without harmonies. But it will happen to persons, little accomplished in musical matters, to be confounded by a known air when played on a full band, while they could readily identify it on a single instrument. Musicians can also identify the key on which a piece is composed, although this point of identity must be enveloped in the widest differences as regards everything else. We are accustomed to find a common emotion in many compositions; we classify airs as martial, gay, solemn, sacred, melancholy, &c. In so far as there is any reality in these distinctions, they are made out by the force of similarity, recalling the past and scattered examples of an effect felt at the present moment. A more substantial agreement is that commonly found in the compositions of the same master. Let a composer vary his works as he may, there is a manner that usually sits upon every one of them; this manner the hearers get accustomed to, and identify on almost any occasion. The identification in the midst of difference is not difficult with the more original composers.

I have remarked a possible difference between the ear for Music and the ear for Speech. Pitch is the leading quality in music, articulation the main peculiarity of speech. In listening to speech, the effects identified by the ear are somewhat different from those above mentioned as belonging to music, although also agreeing in certain particulars. The foremost quality is articulateness, upon which hangs all our perception of meaning; to this succeed pronunciation, accent, cadence, and the accompaniments of manner and gesticulation. (The difference between one voice and another should also be taken into account among the diversifying circumstances.) By 'pronunciation' I here mean simply the manner of articulating the vowels and consonants and separate vocables of the language, as treated of in our pronouncing dictionaries. By 'accent' I understand that indescribable accompaniment with the voice, termed also 'twang' or 'brogue,' and which constitutes the indelible distinction between English, Irish, Scotch, Americans, French, &c., and may subsist along with a perfect sameness of articulate pronunciation. 'Cadence,' I take to mean something more than accent, being the modulation of the voice in consecutive utterance, the peculiar form of elocution fallen upon with the view of making speech agreeable to the ear of the listener; it is in fact the melody of music or speech. This too is natural to some extent, but differing far more among the different inhabitants of the same province, than accent does. Vocal organization, mental character, and education modify the cadence of the voice to very different tunes. Moreover, there is one cadence for conversation, another for reading, a third for public address; oratory consists of the most highly wrought, the most rich and various cadences that the speaker can command. The 'accompaniments of manner and gesticulation' which come to be looked upon as a part of speech, being interpreted by the hearer just as much as the articulate syllables themselves, are likewise a source of diversity, inasmuch as they are conventionally different, while having a certain community of character founded on the natural expression of feeling. If we are accustomed to the very slight degree of gesticulation practised in this country, the action of a foreigner is perplexing, and distracts instead of aiding us in comprehending his meaning.

Taking all these sources of diversity in connexion with the one main feature of articulate utterance, we may derive an unlimited fund of examples of reinstatement made difficult by unlike accompaniments. Voice, pronunciation, accent, cadence, and gesticulation, are inseparable from articulation; and we become accustomed to the sound of words as beset with a particular mode of each of these effects. Often indeed we take up a meaning from manner alone. Accordingly, when we come to listen to strangers, to the people of another province, to foreigners, we experience the difficulty of identifying the articulation in the midst of unusual combinations. The goodness of the ear for articulation proper is submitted to a trying ordeal, as the ear for pitch is tested by the sound of a strange instrument. The trial is greatest of all when we are endeavouring to catch up a foreign language, the ear being as yet unfamiliarized with the new articulations. Here the one effect of the articulation of vowels and consonants, needs to make itself felt amid the distraction of a manifold variety of other effects. Nothing proves so decisively the goodness of the articulate sensibility of the ear, as the rapidity of understanding a foreigner speaking his own language. The power of identifying the essentials of the articulation in the diversity of all else, is in such circumstances conspicuously manifested. It will happen, however, that a person is more than usually sensitive to some of the accompaniments that do not concern the conveyance of the meaning; an ear strongly impressed with the accent and cadence, and permitting itself to be very much engrossed with the different turns of the emphasis and modulation, is by that circumstance rendered more obtuse to the articulate character or to the meaning of the words. The thunder of a diverse and unaccustomed cadence drowns the still small voice of expressive utterance. An acute ear for oratory is thus a great obstruction to the acquirement of languages; an eye unduly oppressed with gesticulate display is an evil in the same way. In listening to our own language, spoken in the style that we are accustomed to, the sensitiveness to those accompaniments is in our favour, and brings home the meaning all the more powerfully; but when they are totally changed in character, as when we listen to a Frenchman or an Italian, we are just as much put out, in identifying the articulation, as in the other case we were assisted. The reinstatement thus depends in part upon the power of attraction we have for the point of sameness, and in part on our not being too sensitive on the points of difference. We shall everywhere observe the influence of both these conditions in determining the reviving stroke of identity.

20. The ear, along with the articulate organs, is, as already remarked, a matrix for holding together our recollections of language. A speech heard is, in part, remembered as a connected series of auditory impressions. Our recollections of this class are likewise liable to be recalled by similarity, even under circumstances of considerable diversity. We can scarcely listen to any address, without being reminded of many past addresses, through the occurrence of phrases, tones,

and peculiarities that lead us into some formerly experienced track of impressions on our ear. The greater our susceptibility to the articulate quality that governs distinctness of meaning, the more readily shall we fall upon previous addresses that correspond in phraseology ; if we are more alive to tone, accent, and cadence, these qualities will preside over the recall of the former occasions when we were in the position of listeners. In this way we are led to detect similarities of manner and phrase in different speakers ; we hunt out imitation and plagiarism, and bring on comparisons among various styles of address. When similarity has brought up the remembrance of a past speaker, we have the further opportunity of noting differences ; but this last operation always supposes that similarity has done its work, in confronting the past with what is now before us. With regard to the diversities that may obstruct the reviving impetus of likeness, they may lie in the context of the agreeing phrases, in the other peculiarities not connected with meaning, or in the subject, matter and sentiment of the address. As in former cases, we pronounce the attraction of similarity powerful when it breaks through a great discordance, and the discordance great that arrests the reviving stroke of similarity; in fact, we must measure each force by the opposition that it conquers. If a verbal likeness has the effect of interpolating some old recollection, in a subject most discordant with it, we pronounce either the verbal action powerful, or the bent of the mind upon the subject feeble, or both.

With reference to the workings of similarity among the sensations of hearing, we have confined ourselves, in accounting for easy or difficult reinstatement, to the character of the ear ; we have not in this case brought in as a possible explanation the general force of similarity in the mind, that force, namely, that would tell equally upon all classes of sensations and thoughts, and make the individual good or bad, on the whole, in the matter of tracing out sameness in diversity. I am induced, from the facts that have come under my observation, to admit the existence of such a pervading characteristic of the brain; and the reader will observe that it has been already invoked as one of the possible explanations of difference of character in reviving sensations of Taste and Smell; but in the special case of the ear, I am strongly impressed with the view, that the nature of the organ itself has much more to do with our powers of acute hearing, and the acquisitions connected therewith, than the pervading characters of the brain or mind in general.

21. Among Sensations of Sight, the occasions for identifying sameness in diversity are innumerable. We can identify *colours* in spite of difference of shade; thus we have a whole class of blues, of reds, of yellows. The existence of such classes implies both sameness and difference; the class-name being derived from the sameness, or the effect common to all the individuals. When a colour is intermediate between two principal colours, as between yellow and red, we may fail to class it with either, not being struck with any feeling of identity in the case; whereupon we constitute a new colour, as orange. It may also happen that, to one mind, the colour may appear as red, and to another yellow, according to the previous impression that it most readily revives. The peculiar effect induced, when colour shines through a transparent surface, may be quoted to exemplify the operation of similarity in vision; for we do not readily identify this effect, in all colours, and in all varieties of the transparent covering; that is to say, such is the diversity, that the perception of sameness is attended with difficulty, and reveals itself to some minds, and not to all. A varnished substance, a glossy fabric, a polished surface in metal or stone, a film of wet, a clear brook, a covering of glass, all strike the mind with a common effect of brilliancy, and if the power of similarity is in effective operation, each one of these effects may recall a great many of the others, so as to muster in the present view a whole class of things very different in general appearance, but all agreeing in a particular impression. According to the reach of mind possessed by the individual, that is, according to the vigour of the identifying stroke, will be the range of

objects brought up from the past at the instance of some one present. Looking at a brilliantly polished marble chimney-piece, one man may be reminded only of polished stones of various kinds; another, breaking through a greater shroud of diversity, compares the effect with metallic polish. Speculating still more deeply on the kind of influence exerted on the mind by such effects, a third person brings up a still more remote subject, varnished surfaces; from these he may proceed to glossy silks and polished leather; and by a stretch still more remote, one may bring the effect of a pebbly bottom, through a clear running rivulet, into the comparison. But in order to carry an identity so far as would be implied in this series of objects, it would be necessary that we should have not merely a keen feeling of the common effect of lustrous brilliancy, but also a notion of its depending on a transparent covering over a mass of colour. This notion, added to the feeling of effect, might enable us, without a great stretch of mind, to break through the great difference between a marble chimney-piece and a pool of water; whereas the feeling of effect, if alone able for such a stroke of identity, would show itself to be intensely acute; otherwise the general force of similarity would need to be very powerful. The case would then be more of the nature of a poetic fetch, a Shakespearian instance; two objects, totally diverse in their appearance to the common eye, recalling one another through the medium of a common emotion. On the other hand, the case of identifying the series, through the *idea* that the transparent surface overlying the colour was the main circumstance of the brilliancy, would be an example of a more intellectual kind of identification, such as a scientific mind is accustomed to strike out.

In the combinations of colour with Form and Size—the optical with the muscular impressions of sight—we have a wide scope for tracing likeness amidst diversity. We identify a common colour through all varieties of objects, large, small, round, square, straight, crooked, here and there and everywhere. Thus it is, that we have in our minds a class-notion for every colour—a common impression of white, red, and blue, derived from every imaginable species of objects. The more susceptible we are to colour, the more deep and permanent and various are these common impressions, and the more easily do we identify a new case with the total of the previous instances of the same colour,—of green, violet, purple, claret, &c.; and the less liable are we to be put out by diversifying circumstances, as by differences of shade, of richness, the addition of lustre, the presence of other colours, the total difference in the material, shape, and size of the objects. When one's hold of colour is but feeble, one is very readily confused by all these circumstances of variety.

The identification and generalization of *forms* in the midst of every possible difference in colour and dimensions, opens up another field of illustration. We identify the circular outline of round bodies; the oval shape of others; there is an infinity of classes determined by form, including not merely the regular figures of Geometry, but all the recurring shapes in nature and art—egg-shaped, heart-shaped, pear-shaped, vase-shaped, cup-shaped, lanceolate, &c. &c. These comparisons arise out of identity in the attribute of form, seen through diversity in all other respects. Most of the identifications are sufficiently easy to strike any observer; while instances occasionally arise where only a certain number of minds are struck with the likeness, or experience the revival of the old upon the new. Thus, in the descriptions of botany, the shapes of leaf and flower are often represented by comparisons that are far from obvious to an ordinary observer. In anatomical descriptions there is not unfrequently an analogous want of obvious resemblance.

The case of mathematical forms and artificial diagrams is both peculiar and interesting; but the important strokes of likeness in diversity that occur in science, are rather more complicated than the examples falling properly under our present head. The generalization of the forms themselves—of triangle, square, parallelogram, ellipse, &c.—through all possible differences of subject, is all that we can quote on the subject of tracing similarity among our sensations of sight. And we may remark here, as on a former occasion, that a strong sensitiveness to the other properties of things, that is, to their colours, dimensions, material, uses, influences on the feelings, &c., is an obstruction to the process of identifying the mathematical form. A burning volcano suggests comparison not with the diagrams of the cone in a book of Geometry, but with images of conflagration and explosive energy.

Of forms not mathematical, we have the alphabetical and other artificial signs and symbols, used both in business operations and in science. In deciphering bad hand-writing there is scope for identifying sameness in diversity. This is like the case of obscure articulation discussed under hearing. A strong sense of the points that make the characteristic difference of each letter, and the obtuseness to all the unmeaning flourishes, are the qualities of a good deciphering head. In proportion as a reader is carried away by ornamental shapes, his power of making out the meaning is impaired. This is the exact parallel of what was said above respecting the effects of over-sensibility to oratorical cadence.

The important case of the revival of language, already brought in, under both articulate action and the sense of hearing, comes in here also, inasmuch as written language appeals to the eye, and is made coherent in the mind in the shape of impressions of sight. What was said above on the resuscitation of past addresses and sayings, through listening to some one speaking, applies to the reader of books. Forms of language and phrases affecting the eye, recall their similars from the past, and break through a greater or less amount of unlikeness, so as to make present at the same time matters written in different places and occasions. An eye very much arrested and impressed with language is to that degree prone to such revivals ; but according as the written symbols are regarded purely as a medium for conveying pictures or information, the tendency to mere symbolical identification is restrained. We have here, as before, occasion to note the *verbal* aptitude of the mind, in contrast to the hold taken of the things that make the subject matter of language, whatever those may happen to be,—whether science, history, poetry, business transactions, or any other. In the verbal mind, as a whole, we can remark the following peculiarities,—1st, The physical power of articulation well developed; this is shown in the easy acquirement of all the positions of the voice and mouth requisite for speech. 2nd. The contiguous adhesiveness of trains of articulate actions, or of the letters, syllables, and words that make up the stream of utterance. 3rd. A good articulate ear, as proved by the test of discrimination. 4th. A corresponding eye for alphabetical or written composition. 5th. A certain pleasure or enjoyment in the exertions of speaking, hearing, and reading, apart from the further ends served by these; this circumstance inspires and sustains the exercise of those lingual functions. To these positive peculiarities, may be added a negative aid, namely, comparative indifference or insensibility to subject-matter. This is the only thing wanted to enable the Faculty of Language to run riot, as we occasionally find it in our experience of men and women.

Artistic forms make a class distinct from both the mathematical and the symbolical. In them the identity is partly in the literal outline, as traced upon the eye, and partly in the effect of it on the mind, as an object of beauty or grace. This last requisite, being the essential feature, must rule the mind in recalling the parallels of something present in the view. Thus, in the drapery of a statue, we identify some effect that we have formerly been impressed with, and the stroke of similarity brings up the former objects to the recollection, on which we find that there is by no means a literal coincidence of lines, and curves, and folds; but the æsthetic similarity has broken through these and other differences, and brought before the mind an instructive array of artistic parallels. A deep feeling of literal or mathematical form would be repugnant to a reinstatement of this nature.

The identification of one Scene of Nature with another may present all degrees of difficulty, according to the predominance of agreement or of difference, and according to the tendency of the mind to be impressed with the one or the other. If the sameness is in form and outline—in the arrangement of mountain, valley, and river—the reviving stroke of similarity turns on the attraction of the mind for unsymmetrical shapes and groupings, one of the features of the catholic susceptibility of the naturalist's mind. If the resemblance to certain other scenes lies in richness, massiveness of colouring, and strength of contrasts, the chord to be struck is of a different kind; and such scenes will be revived in a mind alive to these effects, notwithstanding, perhaps, very great differences in the groupings, or formal arrangements of the component parts.

The same observations are applicable to any other mixed objects of sight or spectacle. When one dress or uniform recalls others; when the *mise en scène* of a dramatic representation suggests parallels from our former experience in those things; when one face recalls another by similarity; or even when a picture revives the original;—in all such cases, the interest, in a scientific point of view, lies in remarking what is the nature of the agreeing particulars, and what are the points of discord. These will determine the sort of mind that would experience the stroke of recall, and the facilities and difficulties belonging to the case for each different variety of mental constitution.

The general power of Similarity would operate alike on all kinds of forms and on all varieties of objects, reviving with equal readiness the similar in colour and in shape. But this general power is modified by the acuteness of the sense, as well as by special education, which deepens the hold that we have of some one class of impressions, and makes us all the more ready to fall into that particular net. Hence it never happens that any individual is equally prone to restore likeness in colour, in geometrical form, in cypher and symbol, and in æsthetic effect.

The last class of objects coming under sensations of Light are *visible movements*. Among those that agree in some point or other, classes are set up, and names given indicating the agreement. The class of projectiles agree in the form of the curve that they take; in like manner, we have circular movements, elliptic movements as in the planets, rectilineal movements, uniform movements, accelerated movements, rotation on an axle, pendulums, waves, zig-zag movements, waterfalls, explosions, &c. Under all these, we may have any amount of diversity in the range and speed, as well as in the thing moved. The movements of animals originate many other varieties; we have all the varieties of movement on all-fours, the walk, trot, canter, gallop, shamble, &c.; the flight of birds, besides having a common character, is marked by great diversity in the different species; the darting to and fro of the bat, the frog-leap, the crawl of creeping things, the sluggish pace of the snail, the dartings of the infusoria, are all distinct types of moving spectacle. By identifications through the stroke of similarity, we bring together into classes a great many instances isolated in their occurrence, and keep hold of them by class-names. We thus generalize the grand varieties of swimming, flying, two-footed locomotion, &c.; and, within each of these, we have a number of minor classes formed in still closer likenesses. In the flexible and various action of a human being, we have many characteristic types of movement and display. The gait in walking, the action in speaking, the mode of performing any work or operation, the movements on the stage, are so many objects that excite our notice, and sink into our minds as permanent recollections. The collective movements of multitudes, either in orderly array and disciplined precision, or in organic tumult and confusion, impress themselves upon the view, and spring up as memories in after times. The moving life, over the face of the globe, and in the habitations of men, is more interesting to us than the still life; it contains more matter of emotion and excitement, and is consequently more dwelt upon, both in present reality, and in idea.

Here, therefore, the force of similarity has a wide arena to act in. The recurrence of sameness in the midst of more or less diversity in all these various movements, leads to identification more or less easy. We identify a style of acting on the stage, a dance, a gait, although the circumstances of the present are very different from the examples lying in the memory. If the agreement is not literal, but in a certain general spirit and effect, a strong sense of the literal will be a bar to the revival of the resembling cases in the past. If we are very sensitive to the stirring effects of movement in general, we are not so likely to identify special curves and patterns, as being similar to others previously known. Easy inflammation to a striking effect blinds us to the accompanying details, according to a principle already adverted to. Movements may be divided and classed in a manner exactly parallel to the threefold division of forms ; *mathematical* or regular movements, as rectilinear, circular, elliptical, &c., comprising all the continuous movements of machinery, and all movements that can be numerically calculated or geometrically traced ; *symbolical* movements, or all those used as arbitrary signs, such as the gesticulation accompanying directions, commands, instruction, and the like, telegraphic signals, the alphabet of the deaf and dumb, the characteristic gait and movements whereby we discriminate persons and animals ; lastly, *æsthetic* movements, or all those that touch the sense of beauty and the interesting emotions. Different minds are variously susceptible to these three kinds, and identify one sort by preference over the others. The æsthetic sense leads to a revival, on that point of resemblance, and obstructs the disposition to classify movements, according to their mathematical character or their arbitrary meaning. The most literal and disinterested susceptibility is manifested to the arbitrary, where neither calculable regularity nor artistic beauty imparts any attractions. The signals of a telegraph, the motions of a fugleman, the signs used in converse with the deaf, are like cyphers and alphabetic letters ; they give scope for pure intellectual identity and discrimination ; they require to be closely observed and literally compared with those previously known ; the differences are arbitrary, and so are the agreements. A cold intellect, with good adhesion for numerous uninteresting and conventional movements, is the basis of their easy recognition.

22. A somewhat interesting class of identities, is that presented by the properties common to Sensations of different senses. Impressions, reaching the mind through different avenues of sense, are yet found to have a sameness in the mental feeling or the emotion, this sameness being necessarily accompanied with the difference due to the diverse entries whereby they reach the brain. For example, many tastes and smells have the character that we call sweet; but there are also effects on the ear, and on the eye, with so much of the same character, that we apply to them the same epithet. In like manner, the character of 'pungency' is common to sensations of all the senses; we have it under taste, in peppered meats; in smell, we have sal volatile; in touch, a scalding warmth; in hearing, drum and fife music; in sight, intense illumination. The amount of sameness in these various sensations is such that one often recalls the others. The identity has been long since made out in many such classes, and, once struck, is clenched and handed down by the use of a common term, as in the above case of 'sweetness.' The opposite quality, 'bitter,' originally referring to taste, has been recognized as occurring in various emotions, as when we speak of the bitterness of disappointment or remorse. The quality that we call 'delicate' has original reference to Touch, but through similarity, it is looked upon as a mode of sensation in all the other senses. Comparisons are instituted between sights and sounds, and the phraseology of the two arts of music and painting is in this way made interchangeable. A picture is said to have a certain *tone;* and a piece of music is, by a less common figure, spoken of as richly *coloured.* The feeling of 'warmth' is identified as belonging to effects that have no connection with heat; we hear of warm colours, and warm affections. Notwithstanding the great disparity there is between an actual sensation of heat, and a colour or a tender affection, there is a degree of sameness sufficient to

break through the discordance in other respects, and bring on the stroke of identification. The designation of one class of sensations as pains, and of another as pleasures, is also an identifying of a common character in the midst of great diversity; but these qualities are usually so well marked in the mind, being, in fact, the prime movers of our actions, that no amount of diversity can prevent us from recognising either the one or the other; indeed a pain not identified as such, that is, not recalling our general notion of pain gathered from the sum of all our painful experiences, would really be no pain.

These generalizations among the feelings of our different senses serve interesting uses. They teach us the existence of common mental effects arising out of very different outward causes, and are, in fact, so many discoveries regarding our mental nature. They also serve as illustrations, one of another, in our descriptions of feelings, whether in the common conversation of society, in the higher sphere of poetic delineation, or for the purposes of science, as in the delineations of the Senses attempted to be given in this work. If we are endeavouring to convey to others some state of feeling that they have not experienced, we must endeavour to bring before their view some identical and parallel state that they have experienced; and therefore we require to possess, through the identifying action of similarity, a store of such likenesses. This is a frequently occurring attempt in poetry, one of whose objects it is to produce new emotions in the minds of men. The illustration of the feeling, roused in the mind of Antonio by music, brings in a complicated reference to the other senses.

> Oh, it came over me
> Like the sweet south upon a bank of violets,
> Stealing and giving odour.

CONTIGUOUS AGGREGATES.—CONJUNCTIONS.

23. Under Contiguity, we had to notice the aggregation of impressions derived from many different sources, through the

circumstance of their proximity or their striking the mind at the same time. I pointed to the association of Feelings of Movement and Sensations with one another, in the notions that external objects create within us, as in the complex idea of an apple, or a piece of gold. I remarked, further, that in many objects the mental impression overflowed, or surpassed, the sensible impression, as in the whole class of Tools, with which are associated *uses*, that is, actions and reactions upon other bodies. In the more profound knowledge of natural things that experimental science yields us, there is a similar addition of associated impressions to the actual feelings of the senses ; the chemical notion we have of sulphur, for example is a complication of this kind.

Now wherever there is much variety or complicacy in the impressions of outward things, there is scope for the detection of likenesses in the midst of diversity. An object acts upon four different senses ; the effect on one sense is identical with an effect formerly felt, but the collateral effects on the three other senses are totally different from the collaterals in the other case. Thus I take in my hand a ball of glass ; to the touch it is the same as a ball of polished marble, and might recall the remembrance of such a ball if I had chanced to have been previously cognizant of one ; but looking at it, and hearing the ring that it makes on being struck, the disparity is notable in both points, and would probably prevent my getting upon the old track of the marble specimen. The most impressive feature of the object being its brilliant effect on the eye, this would have every chance to rule the identifying operation, and prevent me from recalling an object entirely destitute of this peculiarity. There might, however, be circumstances that carried my attention off from this effect, in which case, the round smooth touch might start forth to the dignity of striking the recall.

In the popular classifications made among familiar objects, the identifying process is seen habitually at work. On the landscape we observe an elevation of the ground, an ascent from the ordinary level to a high point or peak ; we note this appearance repeated under a great variety of shapes, and in different situations; we are not prevented by the disparity from recognising the sameness, and the sight of every new individual recalls to the view those that we have formerly seen. We retain in our minds one vast array of objects widely scattered in nature; we give them a common name, mountain, we predicate of each new example the peculiarities that we have found attaching to the previous ones; we then know, without a trial, that if we were to ascend to any one of them, we should experience a wide prospect, a diminishing temperature, and an altered vegetation. We thus group in the mind a number of things not lying together in nature; we also assemble, into one recollection, many widely scattered periods of our past history, being the epochs when we encountered all the different mountains and mountain ranges that make up our catalogue; and lastly, we accumulate a body of information that enables us to infer beforehand, or divine, the characters that we should find, on a close inspection, to belong to every newly-discovered member of the class.

In the same way, and with similar consequences, do we classify numerous other groups of natural objects;—rivers, forests, cultivated fields, lakes, seas, cities, quadrupeds, birds, fishes, &c. Natural History makes a more express business of the classifying operation; it searches all creation in order to exhaust the materials and forms that it contains, and takes precautions to arrive at real and fundamental identities. The progress of Natural History knowledge has been partly in the increase of objects discovered, but partly in the transition from superficial to *deep* identities. In the time of Aristotle, Animals were classified according to the element they inhabited; one class dwelling on the land, another in the sea, a third in the air: this point of identity being so prominent and forcible that it arrested every one's attention. Each of these classes could be subdivided by forming minor groups on still closer resemblances; thus, we should have on the Earth, bipeds, quadrupeds, reptiles, &c., each of these groups being the assemblage of a number of individuals recalled to the iew by special identities. So in the Air, the insect multi-ude would be readily marked off from the feathered tribes. t was not difficult for observing men to draw together classes uch as these. But a more profound enquiry has developed eatures of identification carrying with them a greater amount f agreement, and on points of more value as knowledge, than n those ancient groupings. Birds are now identified not by he circumstance of their flying in the air, but on the fact of heir bringing forth their young in the egg, by their feathered tructure, their warm-blooded circulation, &c. Instead of the ld group of quadrupeds or animals walking on all fours, we ave the class *mammalia* (which suckle their young), in-luding both man and quadrupeds, and certain animals of he sea and the air; this class, therefore goes completely thwart the classification according to the element the crea-ure lives in.

24. The operation of Similarity in such classifyings and e-classifyings as the above, has a very high interest; it sets orth the workings of genius, and the history of science and f the human mind. The reader has not as yet been quite repared for carrying a full explanation over this field of ntellectual labour. It is necessary first to dwell upon less omplicated instances. I might follow the order adopted in eveloping the Law of Contiguity, and specify instances of he aggregation of impressions of the various senses—the Organic sensibility with Taste, Smell, Touch, Hearing, or Sight; and it would be easy to lay hold of many cases of dentity in diversity among such aggregates. Things affecting he palate alike may yet be very different to the touch and ight, as in the different varieties of the same alimentary ubstances,—bread, butter, flesh, &c. Objects that are iden-ical to the eye may yet be utterly different to the taste and mell, as in the case of transparent liquids, such as water, lcohol, nitric acid, and many others. We here make a class ounded on the common peculiarities, and give a designation mplying these and no more. If, however, the taste or smell s the point we are bent on studying, we do not pass from

nitric acid to alcohol and water, but to other substances that we have known with analogous actions on the nose, as the other strong acids and the biting gases ; these are recalled to mind, in spite of differences in all the other sensible properties distinguishing one kind of matter from another. In such cases, it is to be noted, that the diversity is often but very slightly obstructive of the process of reviving the parallel instances, and for this reason, that the mind may be entirely engrossed with the one effect, and inattentive to all the others ; the acid and biting odour may be the sole property of nitric acid that occupies the regards, and the substance is, to all intents and purposes, a substance known by one sense, and recalling former substances identical in their action upon that one sense. This remark is often applicable in the workings of Similarity. Things may have a multiple action on the senses, but if the currents of mental occupation are exclusively occupied with one of the effects, the others are for the time being as good as null ; they neither aid nor obstruct the operations of the intellect stimulated by the one effect of taste, or sound, or sight, which is the engrossing influence at the moment. We have had occasion previously to notice the circumstance, that a diverse feature is obstructive of the reviving tendency of an agreeing feature, in proportion as it has power to seize and occupy the mind ; as when great difference in artistic effect prevents an artist from identifying objects that have a likeness in their material, or in mathematical form,—a burning volcano with a truncated cone in Geometry. The observation is an extremely general one ; for when by obtuseness of sense or voluntary power of resistance, we shut our attention to a circumstance of disparity, it ceases to count as an obstruction to the effect of similarity in other particulars. The overwhelming attractions of the agreeing feature will often of themselves suffice to reduce disagreement to a nullity, even supposing that there is no natural obtuseness, and no effort of volition to withdraw attention from the disagreeing circumstances. Absorbed in listening to a full band, our intellectual trains of identity and comparison turn upon airs, melodies, and harmonies, and not upon the persons, instruments, and incidentals of the performance.

25. I shall not pursue the instances of aggregate impressions on plurality of senses. Passing on one stage farther, let us advert to objects viewed as compounds of Sense and Association. Tools, implements, machinery, and all objects of practical utility, make a class that may stand first in exemplifying this aggregation. A knife, for example, is not simply an object of the senses; it is this and something more. Along with the sensation that it produces in the touch and the sight, there is an associated impression of its use, or of the cutting operation: and we are almost unable to regard it apart from this other circumstance. The appearance of a knife lying on the table is not the whole knife; the appearance of it in the hand while we feel its form and dimensions, coupling sight and touch, is not the whole knife; they are at best but signs or suggestive particulars that revive in the mind, by association, the full notion of the object. Here, therefore, we have a complication of sense and intellect, of impressions made by an actual object, with ideal, or associated impressions, arising from former occasions when we have seen it in its full operation. In this association of sensible appearance with use,—the last being only occasionally seen in the reality, and therefore for the most part an idea, or a potentiality,—we have abundant room for the exercise of tracing likeness yoked with unlikeness. We may have similarity in form with diversity of use, and similarity of use with diversity of form. A rope suggests other ropes and cords, if we look to the appearance; but looking to the *use*, it may suggest an iron cable, a wooden prop, an iron girding, a leather band, or bevelled gear. In spite of diversity of appearance, we are led to bring up what answers a common end. If we are very much attracted by sensible appearances, there will be the more difficulty in recalling things that agree only in the use; if, on the other hand, we are profoundly sensitive to the one point of practical efficiency as a tool, the peculiarities not essential to this will be little noticed, and we shall be ever

ready to revive past objects corresponding in use to some one present, although diverse in all other circumstances. We become oblivious to the difference between a horse, a steam-engine, and a waterfall, when our minds are engrossed with the one circumstance of moving power. The diversity in these had no doubt for a long time the effect of keeping down their first identification; and in many classes of minds, this identification would have been for ever impossible. The regarding of these three things as one and alike implies a remarkable sense of sameness in diversity: the attractive force of similarity behoves to be very energetic, and the aiding circumstances must likewise be very efficient. A strong concentration of mind upon the single peculiarity of mechanical force, and a degree of indifference to the general aspect of the things themselves, must conspire with the intellectual energy of resuscitation by similars, in order to summon together in the view three structures so different. We can see, by an instance like this, how new adaptations of existing machinery might arise in the mind of a mechanical inventor. All new identifications lead to the multiplication of things serving a common end. When it first occurred to a reflecting mind that moving water had a property identical with human or brute force, namely, the property of setting other masses in motion, overcoming inertia and resistance,—when the sight of the stream suggested through this point of likeness the power of the animal,—a new addition was made to the class of prime movers, and when circumstances permitted, this power would be put to use as a substitute for the others. Here would be, in fact, a discovery of a new property of water, and a new invention in the mechanical arts. It may seem to the modern understanding, familiar with water wheels and drifting rafts, that the similarity here was an extremely obvious one. But if we could put ourselves back into an early state of mind, when running water affected the mind by its brilliancy, its roar, and irregular devastation, we might perhaps feel that to identify this with a man's muscular energy for practical purposes, was by no means an obvious effect. Doubtless when a mind arose, insensible by natural constitution to the poetic aspects of things, and devoted to the working out of practical ends, having withal a great stretch of identifying intellect, such a comparison would readily take place; and I am disposed to attribute to great discoverers generally the concurrence of all these three circumstances,—strong attraction for the properties whereon the identification is to turn, comparative indifference to the discrepant accompaniments, and good reach of mind in general. We may pursue the same example one stage further, and come to the discovery of steam power, or the identification of expanding vapour with the previously known sources of mechanical force. To the common eye, for ages, vapour presented itself as clouds in the sky, as a hissing noise at the spout of a kettle, with the formation of a foggy curling vapour at a few inches' distance. The forcing up of the lid of the kettle may also have been occasionally observed. But how long was it, ere any one was struck with the parallelism of this appearance with a blast of wind, a rush of water, or an exertion of animal muscle? The discordance was too great to be broken through by such a faint and limited amount of likeness. In one mind, however, the identification did take place, and was followed out into all its consequences. The likeness had occurred to other minds previously, but not with the same results. These minds must have been in some way or other distinguished from the millions of mankind, and the above is the explanation of this difference that I should be disposed to assign, as deduced from the theory of the human intellect adopted in the present exposition. The intellectual character of Watt is well known to us; and we can have no hesitation in attributing to him a very great susceptibility to the mechanical properties of bodies, or the uses of things as tools and machinery, and a concentration of mind upon this one feature, which would be a practical indifference to all other aspects, together with great reach of the identifying intellect: and I may add, what would be almost implied in these three characteristics, a previous knowledge of the matters likely to rise up to the view under the identifying impulse; for the *previous storing of the mind* must necessarily determine what things will be recalled by the promptings of things present. He that had best studied the existing prime movers would be the person to detect a new one; a far less salient manifestation of the property would awaken in his mind the notion of the others, and lead to the enrolling of the new object in their company. But I am nevertheless persuaded, that equal acquaintance with the known does not imply an equal power of forcing a way into the unknown, by means of the attraction of like for like, through an interval of separation, and a repulsion of unlikeness. It is always difficult to assign the proportions due to different causes, in such a recondite region of nature as the one we are now labouring to elucidate; but the recorded instances of extraordinary genius impugn the sufficiency of any explanation limited to the amount of study, or attention, bestowed on the subject matter of the discoveries.

The foregoing will serve as an example of the workings of our present law in one very wide department of objects. We might under this head have gone a great way into the illustration of practical genius in all departments of life, from mechanical industry, up to those high walks of action where human beings are the tools, as in military and civic command. But I defer for the present any remarks on these applications.

26. Let us next consider Natural Objects, as seen by the eye of the naturalist, with a view to catalogue and exhaust all their properties and relations, whether practical or otherwise. The Mineral, Vegetable, and Animal Kingdoms, as objects of intellectual curiosity and rational explanation, present, in each of their individual specimens, that mixture of the sensible present with the associated absent, above exemplified in the class of tools or machinery. Each mineral, plant, or animal, is a bundle of impressions, of which the whole cannot be made present to the sense at one time, there being a series of actions upon other individuals to be included in the conception, and these usually held together with the assistance of language. The complication thus presented is a degree beyond the pre-

ceding group. In the class of Mineral bodies, for example, we have the concurrence of many attributes in each individual, some sensible, others experimental; and it is under the estranging influence of much diversity that all the classes have been formed. Thus, to take the group of Metals. Some of these have a very large extent of sameness, as tin, zinc, silver, and lead; gold and copper are not very different to the common eye. Iron and manganese show a very close resemblance. But when we come to mercury, a striking point of diversity starts forth; the property of liquidity marks even a contrast with every one of the others. The influence of this diversity, leading the mind away to water and liquids of every kind, would prevent the rise of metals to the view, but for the strong effect of the two qualities of lustre and weight or specific gravity, which acting by themselves could suggest by similarity only such substances as silver, lead, tin, &c. This concurrence of two striking points of sameness, overpowers the diverting influence of the liquid state, and brings mercury to the mind's eye side by side with the metals. But these bodies have been identified with others in the midst of still greater discordance. When Sir Humphrey Davy suggested that metallic substances were locked up in soda, potash, and lime, the identification in his mind proceeded upon resemblances purely intellectual, that is to say, having no direct appearance to the senses, but made out through indirect means, and represented to the mind by technical symbols. He found a class of bodies that had a close agreement with one another, and were termed salts; he saw that some of these consisted of an acid and the oxide of a metal, as sulphate of iron, nitrate of silver; others consisted of an acid and a substance called an alkali, as sulphate of soda, nitrate of potash. Here there were a number of bodies brought together in the mind by general agreement; an oxide of a metal in these bodies suggested by similarity of *function* an alkaline substance, both having the property of neutralizing an acid and forming a salt; it was impossible, therefore, not to class together in one group all substances having this property, which was done before the time of Davy, under the name *bases.* He, by a bold venture, asserted that this common property of neutralizing acids, and making salts, grows out of a still closer identity of character, namely, a common composition; in other words, that the *alkalies were oxides of metals* too, and that therefore all the bases contained a metal and oxygen. On putting the suggestion to the proof it was found to hold good; lustrous metallic substances were actually separated from soda, potash, &c., and the identity made good to the sense as well as to the reason. But to trace identities of this nature, a highly intellectual medium of conception is necessary; salts had to be considered, not as appealing to the touch, taste, and sight, but as compounded of ingredients represented to the mind by names, figures, and symbols. Had copperas been known only as it appears in a drysalter's store, no such identifications could have grown out of its comparison with other salts. It behoved to be known as sulphuric acid combined with oxide of iron, or symbolically as $S\,O^3 + Fe\,O$, in order to see an analogy between it and Glauber's salts, similarly represented, $S\,O^3 +$ Soda. The scientific identities proceed on scientific *conceptions,* that is to say, on artificial ways of expressing by names, numbers, and symbols, the facts that experiment brings to light. The same train of proceeding led to an identification that would have been utterly impossible to the common eye, namely, hydrogen gas with the metals,—a gas with a solid,—the lightest substance in nature with the heaviest. Hydrogen occurs in connexions that inevitably suggest a metal by the force of similarity, as by its combining with oxygen, and entering into still higher compounds exactly as the metals do. The repugnance of the physical or more sensible properties of hydrogen (gaseous form and lightness) to the properties of the metals kept back for a time, but did not in the end prevent, an identification on the property of combining chemically in the same manner as these. And in the artificial representations of chemical formulæ, the identity is such as to strike the eye at once, although this representation was consequent on the recognition of similarity of function in the two cases. An acid is now represented chemically in the same form as a salt, hydrogen standing in the acid for the metal in the salt. Sulphuric acid is H O, S O^3, the sulphate of iron Fe O, S O^3.

27. To pass from the mineral world to the Vegetable. Plants may be identified on many different points, and the same plant may fall into many groups of associates according to the feature that predominates in the mind, and determines the stroke of recall. What in the end has turned out a most valuable classification, was repelled at the outset by obtrusive dissimilarities. In the first Classifications of plants, the Trees of the forest would be grouped together, owing to their easy identification through their prominent and imposing points of likeness. The Shrubs would make another class identified by the same superficial likeness. The apparently insignificant and artificial identification made by Linnæus would be repellent to a common eye, and could only result from minute dissection of the structure, which brought out features of identity hidden in the heart of the efflorescence. The Linnæan classification was properly a fetch of identity in the midst of the widest discordance; and the mental preparation for gaining this triumph of identification, in the midst of difficulties, was a shutting of the eye to the bold features that held all other minds captive, and a devoted study of the minute and concealed structure. The identifying reach of similarity in such a mind must have been of a high order, to produce so great a change in the mode of looking at the whole vegetable world, to break down all the old classifications, and compel the adoption of others entirely at variance with them.

The vegetable world presents us with another example of the attraction of Similarity in a very pure form. The analogy of the flower to the whole plant first struck the mind of the poet Goethe, and was considered by botanists a luminous suggestion. He saw, in the arrangement of the leaves round a stem, the analogue of the circular arrangement of the petals of the flower, notwithstanding very great diversity of general appearance. So in the leaf, Oken identified the plant. The branchings of the veins of the leaf are, in fact, a miniature of the entire vegetable, with its parent stem branches and ramifications. In the first suggestion of these identities, we have notable cases of the stroke of similarity through a dense medium of diversity. Such identifications (when proved to be genuine and not merely apparent or fanciful), cast new lights over a subject; they simplify what is before complex, and give a clue to what seemed a labyrinth.

28. Our next examples are from the Animal Kingdom. We have here cases similar to the foregoing. In the classifications of animals, we find the stroke of identity falling first upon one class of attributes, as in the divisions into quadrupeds, birds, and fishes; this is superseded by a deeper resemblance resting on more minute examination, whereby certain animals inhabiting the sea are excluded from the class of fishes, as the whale, seal, and porpoise, and certain others that fly in the air (the bats for example), are excluded from the class of birds. This new classification, like the reform of Linnæus in the Vegetable world, proceeded on an investigation of structure, and a disregard of the startling differences that arrest the common eye. It was accomplished by the comparative anatomists of the last century, and is now fixed for ever in the minds of men, by the language expressing the divisions and subdivisions of the animal kingdom.

A number of interesting comparisons have been discovered between the different parts of animals taken individually. These are termed *homologies*. The first suggestion of one of their homologies is attributed to the fertile analogical brain of Oken. Walking one day in a forest, he came upon the bleached skull of a deer. He took it up, and was examining its Anatomical arrangement, when there flashed upon his mind an original identity. The skull, he said, was four vertebræ; in fact, the head was merely a continuation of the back bone, but so expanded and distorted as to throw a deep disguise over the fundamental sameness of structure. That disguise was now shot through, by a powerful fetch of similarity, in a mind prepared by previous knowledge for discovering that class of likenesses. Oken was evidently a man that sat loose to the existing identifications of things, and suffered less obstruction than usual from the prepossessions that these fasten on the mind. He had, moreover, a great natural force of the attractive power of like for like, and could make out identities on a small hint. It is further apparent that he had a strong belief in the simplicity of nature, that is to say, in the recurrence, or repetition, of the same structure and the same plan of working, in many various forms and in the most widely separated regions. His conviction on this point went far beyond the reality, as we may see from his writings ; for of the many hundreds of analogies that he sets forth in his one work 'Physio-philosophy,' there are probably not twenty that are sound. The intellectual force of similarity in him was under no check or control. He never took any steps to prove the reality of a supposed identification ; he left that to others. It so happened that in the matter of the skeleton he was right ; but it is only in our own day, that is half a century after the discovery, that the similarity of the bones of the head and the back is considered established. The identifying stroke of similarity, bringing together, for the first time, things that had previously been looked at in totally different connexions, is the first step in a discovery, and only the first step. It has to be followed up by the labour of comparing all the different things whose resemblance is implied in the identification, and it is after this examination is complete, and the result satisfactory, that the discovery is realized. Hence the remark, 'he discovers that proves.' Honour belongs to the first suggestion of a discovery, if that suggestion was the means of setting some one to work to verify it, but the world must ever look upon this last operation as the crowning exploit.

The homologies of the skeleton imply a wide range of similarities, hunted out through the thickest concealment of diversity. The identity of structure of all animals of the vertebrate class,—mammalia, birds, reptiles, and fishes ; the correspondence of the upper arm of the man, the fore leg of the quadruped, the wing of the bird, and the anterior fin of the fish,—implies a very great insight into structure, and a power of setting aside first appearances. The similarity of the segments of the same skeleton, from the crown of the head to the tip of the tail, constitutes the serial homology, which is the working out of Oken's fetch on the skull of the deer. The discovery of these homologies represents the struggles of the human intellect with the perplexity of the world. In the explanation of nature, first thoughts are seldom correct. The superficial resemblances bring together things that have no deep community of structure, and hence no knowledge is derived from one to another. The comparison of a salmon with a seal can only mislead; the comparison of a seal with a whale may improve our knowledge of both. When a superficial likeness in two objects,—a sameness in some one prominent feature,—is the sign of a deep likeness, or a sameness in many other features, all of great importance, we can apply the whole of the knowledge we have obtained of the first to the second; that is, by studying one we are master of the two, and thus economize our labour. If I find out that a bat is not a bird, but one of the mammalia, I instantly transfer to it all that I know of the common characters of the mammalia: but if I identify a bat with an owl I gain nothing, for the likeness between the two (their nocturnal habits) is superficial or isolated, it does not imply a number of other likenesses, and the comparison is therefore unprofitable. The progress of real discovery consists in seizing these pervading resemblances, and in passing by the others. It is a singular fact that where there is the greatest amount of real sameness, there is often the least apparent sameness; which doubtless only shows that the vulgar eye is satisfied with a very narrow and limited glance at things. The kindred features of a family, or class, may not be what gives the individual its popular interest.

PHENOMENA OF SUCCESSION.

29. The successions that make up the flow of changes and events in the world, are a subject of study rising above the

still life aggregates that we have been just considering. Even in those aggregates, we have not absolutely refrained from implying phenomena of succession, as, for example, when we spoke of the experimental properties of bodies; whence it will be apparent, that to deal with the world as we find it, Aggregation and Succession must both be taken into account.

Under Contiguity, we have classified and illustrated the different kinds of succession prevailing around us. Some are Cyclic or periodic, as day and night, the seasons, the heavenly appearances generally; the tides, the winds, the revolution of machinery, the routine of life. Others are successions of Evolution, as in the growth of living beings, and the constructions of human industry. Some are characterized by Effect, or the production of some telling sensation, or sudden change, as in a blow, an explosion, a burst of music, a dramatic scene. Apart from these popular and salient effects, we have the links of succession laid hold of in the Scientific view of cause and effect. Lastly, History at large is a grand *ensemble* of succession, which no one mind can totally comprehend, and which consequently presents itself in innumerable aspects to the intellects of men.

The identifications that have been traced among these innumerable varieties of sequence, and which remain held together, by the use of language, as the common estate of civilized men, have vastly enlarged the sum of human knowledge and the compass of human power, besides yielding much refined gratification. They fall under two great divisions, the Real and the Illustrative; the one implying an identity in the actual subject or intrinsic quality of the sequence, the other implying a sameness in some mode or *aspect* of it. Of the first class, are the scientific and practical identities; the second are those that serve as a medium of intellectual comprehension, or of artistic adornment. When we term certain atmospheric movements aerial tides, thereby identifying them with the tides of the ocean, the comparison is strict and scientific, for both phenomena are caused by one and the same natural power, namely, gravitation; but when we speak of 'a tide in the affairs of men,' the identity is not real, but merely illustrative through a certain similarity of phase or aspect; the ebb and flow of human prosperity has no dependence upon gravitation, it grows out of quite another class of natural impulses. Owing to the fact, that the same effect may be produced by a plurality of causes, there are practical identifications among forces in themselves distinct, as when, in quarrying, we substitute the expansive action of moisture on dry chips of wood, for the explosion of gunpowder. The sources of power in these two effects are not the same; they do not fall under a common natural cause. Nevertheless, this, too, would be called a real, and not an illustrative identity; it would be *fructifera*, and not *lucifera*, or *poetica*.

30. The illustrative comparisons, however, are not confined to phenomena of succession; they occur equally among the objects brought in under the previous head, namely, aggregates, conjunctions, or appearances of still life. On this account I prefer to treat 'illustration' as a separate subject, and under the present head, 'successions,' I shall merely cite a few examples of the identification of likenesses considered as real, or believed to be real. And to commence with sequences that are periodic or Cyclic :—the revolutions of the year are too much alike to present a case of difficult identification, on which alone any interest hinges. In the rising and setting of the stars, there is one point of similarity that might for a long time escape observation, in consequence of accompanying dissimilarities, namely, that in the same place the stars all rise constantly at the same angle, the angle being the co-latitude of the place; at latitude 60° the angle is 30°, at latitude 50° it is 40°. Now there are two disguising differences in the rising and setting of the various stars; one relating to the height they reach when at their highest, and the other relating to their time of rising, which last element differs for the same star throughout the year. It takes a steady glance, a ready appreciation of mathematical elements (such as this of the angle of rising), and a considerable reach of the identifying faculty, to make out, for the first time, a common

feature of this description in the midst of a dazzling and variegated scene. An absence of poetic feeling would be almost an indispensable requisite.

In the Vegetable Kingdom, as seen in temperate and cold countries, men soon attain to the generalization of alternating life and death, in the cycle of the year. Notwithstanding the boundless variety and diversity of vegetable nature, this fact, of summer growth and autumnal fading, is too prominent to be disguised by the distinctions between a garden flower and a forest oak. It would consequently be one of the earliest generalizations of the human race living out of the tropics. The same remark would apply to the alternation of waking and sleeping, as a fact of animal life in general. The identification of the daily repose of men and animals with the hybernation of reptiles and some other classes, would be somewhat less obvious, but by no means difficult to observant men; unless indeed an artificial obstruction were created by the comparison with death, or with the winter of vegetation, having already got possession of men's minds. We have had occasion to remark the influence of prepossessions in stifling a stroke of identity otherwise not difficult.

The steps of the generalization of the planets, or the tracing of a common character, in spite of accompanying dissimilarity, among these wandering bodies, would be interesting to follow, if we could now recover them. The discovery of the common fact of their circling round the entire heavens, was by no means easy in the case of the inferior planets, Mercury and Venus, seeing that men's minds would in their case be carried away with the more limited circumstances of their attending on the sun, and appearing as morning and evening stars.

The successions of Evolution are typified, and principally constituted, by the growth of living beings. Each plant and animal, in the course of its existence, presents a series of phases, and these we may watch more or less closely, so as the better to know the course of the evolution. With the fact of birth and death, as a property of all living beings, we become acquainted through the identifying operation, which seizes hold of this common feature, in the midst of variety in all else that can constitute a living being. But identities of the special mode of growth can be traced among limited groups, which are thereupon formed into classes; as in animals, the Oviparous and the Viviparous. The successions of insect life are peculiar and interesting, and, as regards the distinct stages and states of existence, the identifications through the animal tribes are curious and instructive. Close observation of individuals is necessary to put the mind in a position to strike out such identities; the absence of vulgar wonderment, poetic illusion, and strong prepossessions in favour of some mistaken comparison, is also very helpful. The physiological department called Embryology, includes the knowledge of the early evolution of animals, and is very much dependent upon identifying the modes of growth of creatures considerably different from one another, as the chicken and the infant. Here, however, there was no great reach of mind needed to suggest the identity of these two; the difficulty in such a case is to prove that an obvious and apparent identity is real and deep, or so close, that what is known of the one member of the comparison may, with absolute certainty, be believed of the other. Whereas in other instances the discovery is difficult, but the proof easy, in this the discovery is easy, and the proof difficult. With the intellectual operations required to ascertain the genuineness of an identity seen by the intellectual glance of similarity, the *logic* of the case, we are not at present concerning ourselves.

31. The Successions that make Human History, present a choice field of illustration of the mental force of Similarity. Nowhere are comparisons, good and bad, more abundantly struck. Plutarch is not the only writer that has set to work expressly to construct historical parallels.* In the situations

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* See the interesting volumes under this title, published by Charles Knight.

that arise in public affairs, in the problems that have to be solved, in the issues of critical periods, and in the catastrophes that have overwhelmed empires, the intellect of enquiring and observing men finds numerous identities. Sometimes we compare the past with the present, sometimes one past epoch with another. And such comparisons are seldom barren efforts of the identifying faculty; they are usually employed for some end of mutual illustration, or in order to infer in the one all the good or bad features belonging to the other. The rise of the British empire is compared, by one class of minds, to the history of the great empires of antiquity, the object of the comparison being to carry out the analogy to the full length of anticipating for Britain a similar course of decay. The parallelisms that set forth popular government, as conducting to anarchy and ending in military despotism, have been repeated *ad nauseam*. It is not such very large comparisons that illustrate happily the operation of the principle now under discussion, or that show the results of identification in enlarging the grasp of the human intellect. For these ends, I should choose rather to point to comparisons made in very limited chains of historic succession. The narrower the field of view contemplated, the more chance there is of hitting upon a real and instructive comparison. Take the following from GROTE'S *History of Greece*. In discussing the changes made in Sparta by the institutions of Lycurgus, the historian calls in question the alleged re-partition of the lands of the state among the citizens. He shows that this is not stated by the earliest authorities, and that it appears to have gained credence only after the revolutionary proceedings of Agis and Kleomenês in the third century, B.C.; at which time he thinks the idea grew up in consequence of its being strongly suggested by the present desire for a similar re-division. 'It was under the state of public feeling which gave birth to these projects of Agis and Kleomenês at Sparta, that the historic fancy, unknown to Aristotle and his predecessors, first gained ground, of the absolute equality of property as a primitive institution of Lycurgus. How much such a belief would favour the schemes of innovation is too obvious to require notice; and, without supposing any deliberate imposture, we cannot be astonished, that the predispositions of enthusiastic patriots interpreted according to their own partialities an old unrecorded legislation, from which they were separated by more than five centuries. The Lycurgean discipline tended forcibly to suggest to men's minds the *idea* of equality among the citizens—that is the negation of all inequality not founded on some personal attribute—inasmuch as it assimilated the habits, enjoyments, and capacities of the rich to those of the poor; and the equality thus existing in idea and tendency, which seemed to proclaim the wish of the founder, was strained by the latter reformers into a positive institution which he had at first realized, but from which his degenerate followers had receded. It was thus that the fancies, longings, and indirect suggestions of the present assumed the character of recollections out of the early, obscure, and extinct historical past. Perhaps the philosopher Sphœrus of Borysthenês (friend and companion of Kleomenês, disciple of Zeno the Stoic ,and author of works now lost, both on Lycurgus and Socrates and on the constitution of Sparta) may have been one of those who gave currency to such an hypothesis. And we shall readily believe that, if advanced, it would find easy and sincere credence, when we recollect how many similar delusions have obtained vogue in modern times far more favourable to historical accuracy—how much false colouring has been attached by the political feeling of recent days to matters of ancient history, such as the Saxon Witenagemote, the Great Charter, the rise and growth of the English House of Commons, or even the Poor Law of Elizabeth.'* The comparisons contained in this last sentence, both suggest the explanation above given of the rise of the belief in question, and give probability to it when suggested. The same historian has effectively illustrated the general body of Grecian legends, by a comparison with the middle age legends

* Vol. ii., pp. 538-40.

of the Roman Catholic Church. The range of knowledge possessed by an historical enquirer on the one hand, and the force of his identifying intellect on the other, are the sources of his fertility in those comparisons that illuminate the darker specks of the ill-recorded past. Whether those comparisons are strictly applicable and good, depends on a quite different mental peculiarity, already more than once touched upon, his sense of accuracy and precision, or what is sometimes called the logical faculty. We find among historians, no less than among Zoological enquirers, the characteristics of the *Oken* mind; a fulness of analogical suggestiveness with an absence of the tests of soundness.

32. It is not stepping far out of the class of instances typified in the foregoing paragraph, to advert to Institutional comparisons, whether of different ages or of the same age. The social and political institutions of nations and races have often points of agreement in the midst of great diversity; and a penetrating mind, in other words a strong identifying faculty, can bring together the like out of the enveloping clouds of unlikeness. It is easy, for example, to identify the fact of government as belonging to every tribe of men that act together; so, it is not difficult for one absolutism to bring before the view all the other instances of absolutism that have at different times been impressed on one's mind; and the same with free or responsible governments. By this operation, we gather up various classifications of agreeing institutions, the one throwing light upon the other, and the whole concurring to make one broad luminous effect, which we call the general impression of government; of absolutism, of constitutionalism, &c. The vast complexity and seemingly endless variety of human institutions is thus simplified in a remarkable degree; out of chaos order arises, as soon as similarity begins to draw together the agreeing elements of the discordant heap. Our great writers on Society, Aristotle, Vico, Montesquieu, Condorcet, Hume, Millar, James Mill, De Tocqueville, have shown admirable tact in this kind of Comparative Anatomy, and with all the effects of intellectual illumination and expansion

that flow from the bringing together of remote samenesses. What the historian does incidentally, the writer on Society does upon system ; he searches the whole world for analogies, and finds, if possible, a class for every variety that presents itself. Forms of Government, of Legislation and Justice, Modes of Industry, Distribution of Wealth and Arrangement of Ranks, Domestic Institutions, Religion, Recreative Amusements, &c., are identified and classified so far as they agree, with notification of difference, and out of the *particulars* drawn together in a powerful identifying mind there crystallize, one after another, the corresponding *generals*, and the human reason advances in its endeavours to comprehend this wide subject.*

33. To return to successions. There remains one other class to be cited in illustration of our general theme, namely Cause and Effect, or those successions where the consequent depends on its antecedent, and is always produced by it. Here we have to remark, that often the same link of causation occurs in circumstances so widely apart, that the sameness is veiled from the perception of the general mass of minds ; indeed it not seldom happens, that until some preparatory operation has had the effect of drawing aside the veil, the identity does not disclose itself to the most piercing intellect. Thus, to take the two phenomena of combustion and the rusting of iron, it was not possible for any mind to see a common feature in these two effects as they appear to the common eye. A long series of investigations to ascertain more particularly the import of each of the two actions apart, had first to be gone through. Other phenomena had to be interposed having relations to both, in order that actions so unlike should be seen as like. The experiments of Priestley upon the red oxide of mercury were a turning point in the *rapprochement*. These experiments showed that when mercury was burned it became heavier, by taking in some substance from the air,

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* See Millar *on Ranks*, and the examination of the Hindu Institutions in Mill's *History of British India.*

which substance could again be driven off, and the metallic mercury reproduced. The act of combustion of the mercury was to all appearance identical with the burning of coal in a fire, while the resulting change on the substance, the conversion of the metal into a red powder, might suggest the process of the rusting of iron, the chief point of diversity being the time occupied in the two different operations. Through an intermediate phenomenon like this, the two others might come together in the mind as identical, and they are now known to be the results of the same operation, or effects of the same cause, namely, the combination of the solid material with the gaseous oxygen of the atmosphere.

In the great problem of Inductive Science, stated to be the discovery of the effects of all causes, and of the causes of all effects, there are many intellectual operations gone through; —the problem puts on many different aspects. But the importance of a powerful reach of the identifying intellect is constantly made manifest. Some discoveries turn upon this exclusively; and no succession of discoveries can proceed without it. In truth, the very essence of *generalization* being the bringing together of remote things through the attraction of sameness, this attractive energy is the right hand of a scientific inquirer. To cite the greatest example that the history of science contains, the discovery of universal gravitation, or the identifying the fall of heavy bodies on the earth with the attraction between the sun and the planets; this was a pure stroke of similarity, prepared by previous contemplation of the two facts apart. Newton had for years been studying the celestial motions: by the application of the doctrines of the composition and resolution of forces to the planetary movements, he had found that there were two actions at work in the case of each planet, that one of these actions was in the direction of the sun, and the other in the direction of the planet's movement at each instant—that the effect of the first, acting alone, would be to draw the body to the sun, and the effect of the second, acting alone, would be to make it fly off at a tangent, or in a straight line through space. By this process of decomposition he had reduced the question to a much simpler state; he had in fact prepared the phenomenon of planetary motion for comparison with other movements already understood. This operation of analysis was itself a remarkable effort of intellect; no other man of that time showed the capability of handling the heavenly motions with such a daring familiarity—of intruding into their spheres the calculations of a terrestrial mechanics. This preparatory operation was perhaps a greater feat of intellect than the flash that followed it; indeed the perception of identity could not be long delayed after such a clearing of the way. He had familiarized himself, as the result of this mechanical resolution of the forces at work, with the existence of an attractive force in the sun, which acted on all the bodies of the system; and he had discovered, by a further effort of calculation, that this force varied inversely as the square of the distance. As yet the phenomenon of solar attraction stood solitary in his mind, but it stood out as a remarkably clear and definite conception, so definite and clear that if ever he came to encounter any other phenomenon of the same nature, the two would in all probability flash together on his mind. Such was the preparation on the one side, the shaping of one of the two individual phenomena destined to become one. Then as to the other member. He had been familiarized with the falling of bodies from his infancy, like everybody else; and the impression that it had made, for a length of time, was as superficial as it had been in the minds of his brethren of mankind. It was to him as to them a phenomenon of sensible weight, hurts, breakage; it rendered necessary supports and resistance. This was the view naturally impressed upon his mind, and, in this encumbered condition, an identity with the pure and grand approach of the distant planets towards the sun, while yet held at distance from him, was not to be looked for, even in the mind of Newton, whose identifying reach was, undoubtedly, of the first order. He had been for a length of time in possession of the prepared idea of solar force, without its ever bringing to his mind, for comparison, the familiar fact of a body falling to the earth. It was obviously necessary that some preparatory operation should take place upon this notion likewise; some contemplation that would partially clear it of the accompaniments of mere smash, breakage, weight, support, &c., and hold it up in its purest form, as a general movement of all free bodies towards the earth's surface, or rather in the direction of the earth's centre. Here, too, there was need of an analytic or disentangling procedure, an operation very distasteful and repellent to the common mind, and stamping the scientific character upon any intellect that is at home in it. At what time Newton laid his analytic grasp upon this ancient experience of our race, we may not now be able precisely to determine; it may have been the commonly recounted incident of the fall of the apple that set his mind to work, or it may have come round in the course of his studies of terrestrial phenomena. But I cannot help supposing, that, when the phenomenon was once taken to task in the way he had already been accustomed to deal with such things, he would very soon identify and eliminate the main fact from all the confusing circumstantials, and see in it an instance of the motion of one body towards another, by virtue of some inherent power in the attracting over the attracted mass. This eliminating generalization would present the case pure and prepared to his mind, as the other had already been by a previous operation; and then came the flash of identification, and with it the sublime discovery that brought heaven down to earth, and made a common force prevail throughout the solar system. Not less to his honour than the discovery itself, was his reserving the announcement, until such time as the proof was rendered complete, by the arrival of an accurate estimate of the magnitude of the earth, which was a necessary datum in the verifying operation.

This great stretch of identification, perhaps the widest leap that the intellect of man has had the opportunity of achieving, not only illustrates the mental attraction of similarity, but also presents in relief the preparation of the mind for bringing on the flash. We see the necessity there was, for a powerful mathematical faculty to seize the laws of the composition and resolution of forces, and to apply them to the complicated case of elliptic motion; in this application, Newton already made a step beyond any mathematician of the age. We observe, in the next place, the intense hold that the mathematical aspect of the phenomena took on his mind, how he could set aside or conquer all the other aspects so much more imposing in the popular eye, and which had led to quite different hypotheses of the cause of the celestial movements. This characteristic shines remarkable throughout the scientific writings of Newton; however fascinating a phenomenon may be, he has always his mind ready to seize it with the mathematical pincers, and to regard it in that view alone. His mode of dealing with the subject of Light is an instance no less striking than the one we have been now setting forth. There was in him either an absolute indifference to all the popular and poetic aspects of an appearance, or a preference for the scientific side, strong enough to set all these aside. The example he set of uncompromising adherence to the relations of number and measured force, was probably the most influential result of his genius, at a time when physical science was as yet unemancipated from the trammels of a half-poetic style of theorizing. The purification and regeneration of the scientific method was far more owing to the example of Newton than to the rhetorical enforcements of Bacon. The human intellect was braced by dwelling in his atmosphere, and his avatar was the foremost circumstance in giving a superior stamp to the career of thought in the eighteenth century.

To these two peculiarities of the Newtonian mind—mathematical power, and exclusive regard to the mathematical and mechanical, in other words, the strictly scientific aspect of the phenomena to be studied—I have added a third, which, although not radically distinct from these, deserves separate notice; I mean analytic force, or the tendency to separate the effects that an object has on the mind or senses, and to concentrate the regard on one particular at a time. Thus we have seen that a falling body produces a very complex impression—a gross and multifarious effect—and this total mass of sensation and feeling is the popular notion of the phenomenon. No accurate knowledge can grow out of such aggregates; they are the soil of poetry, not of science. I shall illustrate afterwards the nature of this force, or impulse, of mind that resists the totalizing influence of a complex object, and isolates for study and comparison its individual effects; I note it here as the volitional, or what may be loosely styled the moral, element of the scientific intellect; it stood forth in singular grandeur in the mind of Newton. All the three peculiarities now stated came in aid of the identifying stretch of similarity, but could not dispense with the presence of this also in a more than ordinary degree.

REASONING AND SCIENCE IN GENERAL.

34. Not to mention the examples that we have just parted from, many of the instances of Similarity already adduced in the course of our exposition are strictly of the nature of science. I think it right, notwithstanding, to devote a separate head to the operation of the law in the various scientific processes, with a view to elucidating farther both it and them. I shall therefore make the illustration fall under the four divisions of Abstraction, Induction, Deduction, and Analogy.

Classification, Abstraction, Generalization of Notions, General Names, Definitions.—These designations all express substantially the same operation, that of identifying a number of different objects on some one common feature, and of seizing and marking that feature as a distinct subject of thought; the identification being a pure effort of similarity. Thus we identify the different running streams that have come under our observation, in consequence of the sameness that stands prominent in the midst of much diversity; any new one will recall the previous ones, and they are assembled together in the mind not as a miscellaneous aggregate, but as a class strung together on a common thread. In this connexion, they serve to improve our comprehension, one of the other; some we know chiefly at the sources, others at the mouth, some in the mountains, others in the plains; accordingly, we supply gaps in our knowledge of each by means of the rest. We may go the length of deriving out of the fragmentary views some one unbroken whole, an ideal river, that shall include all the features of a perfect river in goodly proportions; or we may simply choose one that we know better than the rest, as our representative instance, and from it supply blanks in our view of those that we have less perfectly examined. This mutual supply of defects in the picture, is one of the advantages of assembling objects in a class; a second advantage is the substitution of one for another in any practical end; we know, for example, by some single experience, that a river bank is a convenient site for a town or village, and as a consequence of the discovery of identity, we can choose any one of all the rivers in our knowledge for the same object. Here, then, we have first a *classification*, assembled by the attraction of similarity; secondly a generalization, or general notion, or *abstract idea*, being some typical river that fairly represents the group, and in which we include only what they all have in common; this typical river may be one of the number, or it may be a composition out of several. Thirdly, we have the application of a *general name* to the class, the name 'river,' which shall express both the whole, and what each has in common with every other. A fourth operation is all that is necessary to complete the work, namely, to furnish a *definition* or an expression in language of the class features or common properties* of the class. This exhausts the series of operations connected with the generalization of objects taken as a total or a unity; of these, the first grows out of pure Similarity, the others suppose a somewhat more complicated action, to be afterwards described.

Take again the genus of Round bodies. As before, these are mustered in a class by the attraction of sameness; their classification has the effects, already specified, of mutual enlightenment and mutual exchangeability. To clench the

* A river may be defined 'a natural current of water flowing in an open channel towards the sea,' or to that effect.

operation, we seize upon some one instance as a representative or typical instance, and our idea of this we call the abstract, or general, idea. We can here adopt a very refined method; we can draw an outline circle, omitting all the solid substance, and presenting only naked form to the eye; this is an abstraction of a higher order than we could gain by choosing a specimen circular object, as a wheel, for it leaves out all the features wherein circular bodies differ, and gives the point of agreement in a state of isolation. The mathematical diagram is thus a more perfect abstraction than the idea of a river or of a mountain, derived from a fair average specimen, or a composite river or mountain; these last scarcely come up to the meaning of an abstraction, although when properly managed they serve all the ends of such. But we may pass, in the present case also, from an abstract conception, or a Diagram, to a Definition by descriptive words, and we may adopt this as our general conception, and use it in all our operations instead of, or along with, the other.* The definition is in fact the highest form of the abstract idea, the form that we constantly fall back upon as the test or standard for trying any new claim of admission into the class, or for revising the list of those already admitted.

35. *Induction, Inductive Generalization, Conjoined Properties, Affirmations, Propositions, Judgments, Belief, Laws of Nature.*—The contrast between Abstraction and Induction as here understood may be expressed thus: in the one a *single* isolated property, or a collection of properties treated as a unity, is identified and generalized; in the other a conjunction, union, or concurrence of *two* distinct properties is identified. When we bring all rivers into one class, and define the property common to all, we exemplify the first process; the second process, Induction, is exemplified when we note the fact that rivers wear away their beds, or the fact that they deposit deltas at their mouths. In this case two *different*

* A circle is defined to be a line everywhere at an equal distance from a point which is the centre.

things are conjoined; the flow of water over a country to the sea in an open channel, which makes the idea of a river, is associated with the circumstance of depositing or forming land in a particular situation. This conjunction makes an Affirmation, or a Proposition; the idea of a river by itself, or anything expressed by a noun, is not an affirmation. When we affirm the uniform co-existence of two distinct facts, we have a Law of Nature, an intellectual possession respecting the world, an extension of our knowledge, a shortening of labour. Of the two conjoined things, the presence of one is at any time sufficient to assure us of the presence of the other, without farther examination. As surely as we meet with a river, so surely shall we find the carrying down of mud to be deposited at the mouth, if the two facts be really connected as we suppose. An abstraction or definition gives us a general *idea*, it assembles a class of things marked by the presence of this common feature,—the class river, the class circle, the class red, the class planet, the class just,—but does not convey a proposition, a law of nature, a *truth*.

In forming these inductive generalizations, we need the identifying impetus pretty much as in abstractive generalizations. The case is distinguished only by being more complex; it is properly a stage beyond the other in the order of discovery, although the two are very apt to be mixed up and determined by one and the same effort of the sense and the understanding. Still, in order to arrive at the knowledge that rivers form bars and deltas, we require to have observed the peculiarities of rivers, and to have been struck at some moment with their identity on this point; standing at the mouth of one and observing the island which parts its stream, we are reminded, by a stroke of reinstating similarity, of the mouth of some other where a similar formation occurs, with perhaps many points of diversity of circumstances. These two coming together will bring up others, until we have assembled in the mind's eye the whole array that our memory contains. This is the first stage of an inductive discovery; it is the suggestion of a law of nature, which we are next to express and verify.

The conflux of all the separate examples in one view indicates to the mind the common conjunction, and out of this we make a general *affirmation*, as in the other process we make a general notion or idea. But a general affirmation by language makes in this case a proposition, not a definition; it requires a *verb* for its expression, and carries a law or a truth, something to be believed and acted on.

In like manner, it is by an identification of the separate instances falling under our notice, that we are struck with the conjunction, in an animal, of cloven hoofs with the act of ruminating and with herbaceous food. So, to take a more abstruse example, we identify the conjunction of transparency in bodies with the bending of the rays of light; these transparent bodies are of very various nature,—air, water, glass, crystalline minerals; but after a certain length of observation the identity makes itself felt through them all. By an *abstractive* process, we gain the general idea of transparency; by looking not simply at the fact of the luminous transmission but at the *direction* of the light, we generalize an *induction*, a proposition, conjoining two properties instead of isolating one. The operation of induction is thus of the same nature, but more arduous, and implying more labour, than the operation of abstraction. The same cast of mind favours both; the same obstructions block the way. To make a scientific induction, the mind must have the power of regarding the scientific properties and disregarding the unscientific aspects; in discovering the refraction of light, the attention must fasten on the circumstance of mathematical direction, and must not be carried away with vulgar astonishment as the distorting effect upon objects seen through water or glass. To take in the more abstruse and dissimilar instances, as the refractive influence of the air, there is needed a preparation similar to that already exemplified in the identification of burning and rusting.

Sometimes an induction from a few identified particulars can be *fitted in* to a previously established formula or generalization. The above instance of the refraction of light furnishes a case in point; and I quote it as a further example of the identifying operation. The bending of the light on entering or leaving a surface of glass, water, or other transparent material, varies with the inclination of the ray to the surface; at a right angle there is no bending, at all other angles refraction occurs, and it is greater as the course is farther from the right angle, being greatest of all when the ray lies over so much as almost to run along the surface. Now, an important identification was here discovered by Snell, namely, the identity of the rate of refraction at different angles with the trigonometrical relation of the sines of the angles, expressed thus :—the sines of the angles of incidence and refraction bear a constant proportion within the same medium, or the same kind of material. Here the observed amount of the bending at different angles, was found to accord with a foregone relation of the mathematical lines connected with the circle. This too may be looked upon as a discovery of identification, demanding in the discoverer not only reach of the faculty of Similarity, but antecedent acquirements in the geometry of the circle, ready to be started by such a case of parallelism as the above. Inductions falling into numerical and geometrical relations, previously excogitated, occur very frequently in the progress of discovery. All Kepler's laws are identifications of this nature; the third law, which connects the distances of the planets from the sun with their periodic times, is a remarkable case. He had before him two parallel columns of numbers, six in the column, corresponding to the six known planets; one column contained the distances, another the times of revolution; and he set himself to ascertain whether the relations of these numbers could come under any one rule of known proportions :—they were not in a simple proportion, direct or inverse, and they were not as the squares, nor as the cubes; they turned out at last to be a complication of square and cube. The law of areas is perhaps an equally remarkable example of a series of particulars embraced in an all-comprehending formula, got out of the existing stores of mathematical knowledge; but in all these discoveries of Kepler, we are perhaps to admire the aims, the determination and perseverance of his mind, still more than the grasp of his intellect. We have before remarked, that for a man to extricate himself from the prevailing modes of viewing natural appearances, and to become attached to a totally different aspect, is itself the proof of a mental superiority, and often the principal turning point of original discovery. The identifying faculty in Kepler showed itself less prominently in the strokes of detail, than in the mode of taking up the entire problem, the detection of a common character in the motions of the planets and the relations of numbers and curves. To make that a pure mathematical problem, which really is one, but has not hitherto been sufficiently regarded as such, is itself a great example of the scientific intellect; it was the glory alike of Kepler and of Newton. A previously equipped mathematical mind, an indifference or superiority to poetical and fanciful aspects, and a high reach of identifying force, concur in all the authors of discoveries that bind the conjunctions of nature in mathematical laws. The great revolution in Chemistry made by the introduction of definite combining numbers, has been even more rapidly prolific of great consequences, than the discoveries that gave Mechanics, Astronomy, and Optics the character of mathematical sciences. The introduction of vigorous numerical conceptions into the subtle phenomena of Heat, through Black's doctrine of latent heat, exhibits a stroke of high intellect not inferior to any of those now adduced. The difficulty of seizing the phenomena of freezing, melting, boiling, and condensing, in a bald, numerical estimate, is attested by the lateness of the discovery, if not sufficiently apparent to one that considers how very different from this is the impression that these effects have on the common mind. The engrossing sensations of warmth and cold, the providing of fuel and clothing, the prevention of draughts, or the admission of cool air, are the trains of thought usually suggested by the various facts of congelation, liquefaction, &c.; to enter upon the other trains is the result of a special training and endowment, the explanation of which, according to general laws of mind, has been one of the aims of our protracted examination of the human intellect.

36. *Inference, Deduction, Ratiocination, Syllogism, Application* or *Extension of Inductions.*—I have repeatedly urged the value of the identifying process in extending our knowledge, by transferring all that has been ascertained in some one case to every other case of the same description. This operation is described under the above titles. It is an Inference, a Deduction, a step of Reasoning, the Extension of an Affirmation from the known to the unknown. The discovery of a true identity* between the new cases and the old, is a justification of this transference of properties. Having observed, in innumerable cases, that human beings go through a course of birth, maturity, decay, and death, we transfer their fate to those now alive, and we declare beforehand that each and all of these will go through the same course; this is to make an inference, to *reason,* to apply our knowledge to new cases, to know the future from the past, the absent from the present. So, when we land on the banks of a strange river, we instantly act on the assumption that this river has its origin in high lands, its destination in the sea, and has at its mouth a deposit of mud of larger or smaller dimensions. The little that we see of the river, by walking a few miles along its bank is enough to identify it with the rivers already known to us, or with our general notion, or abstract idea, or definition of a river, and on this identity we forthwith transfer all our experience connected with rivers in general, and all their conjoined phenomena, to the newly occurring individual case. When our knowledge comes thus to transcend our actual experience, an inference, or act of Deduction or Ratiocination, is performed.

Mr John Stuart Mill, in his *System of Logic,* has shown I think, conclusively, that the basis of all inference is a transition from particulars to particulars, and not, as usually sup-

* It is not within the scope of this treatise to explain fully the nature of the evidence which the scientific man requires, in order to be satisfied that a supposed identity is real, true, or genuine, or a sufficient basis for deductive inference. Such an explanation is most amply supplied in the work mentioned in the next paragraph.

posed, the application of a general affirmation to the special affirmations included in it. In fact, he maintains that when we say 'all men are mortal,' we have already inferred the utmost that it is possible to infer; for out of our experience of the men that have lived and died, we have constructed an assertion applying to all men now living and all that are yet to be born, so that no further deduction remains to be made; the applying of this affirmation to a particular individual or tribe, as to the present inhabitants of London, or the present Emperor of China, is not an inference, it is but to enunciate in detail what has been already enunciated in the gross or total—it is not to make any new step, or to take up with any new piece of information, any new belief. Hence to syllogize is only to go through a form of reasoning; it is to take precaution against one particular source of mistake, namely, the mistake of wrongfully including an individual in a general class. If we say, all men are mortal, therefore the angel Gabriel will die, the badness of the reasoning will be exposed by giving it the syllogistic form, thus: all men are mortal, the angel Gabriel is a man, Gabriel will die. Here, by completing the form, we see what assertions we make previously to drawing the conclusion, and that while the major, or principal, proposition, all men are mortal, is true, the second, or minor proposition, that Gabriel belongs to the class of men, must also be verified. The stress of the syllogism lies not in extending our knowledge to new cases, for this extension is complete when a general proposition is risked, but in making sure of the *relevancy*, the applicability to the case in hand; it demands us to make a solemn, deliberate, overt assertion of the identity of the specific case with the cases contemplated in the already generalized affirmation; and there is a certain likelihood that a person, in making this assertion, will feel that he ought to be quite certain of its accuracy, before committing himself to such a broad avowal as this formality brings him to.

This process of inference, or extension of properties, therefore, evidently comes of the identifying faculty, by which the new cases and the old are brought together in the view. If the question be, given a certain number of particulars, where a natural law is exemplified, to discover other particulars whereto we may extend or apply the law, and so reveal new characters in those particulars, these new cases must be summoned to the view by a stroke of similarity. Thus, Newton observed, in various instances, that, when a transparent body is largely made up of combustible matter, as an oil or a resin, it bends light to an unusual degree; in other words, he made an induction of particulars where combustibility of substance and excessive bending of light were conjoined properties. He next bethought himself of any other substances, besides those in the immediate view, that possessed one of these properties, and his recollection of the refracting power of the diamond responded to his call by a stroke of similarity; he thereupon extended to the diamond the other property, namely, combustibility of material; or *inferred*, what no one had ever experienced, that the diamond is a combustible substance, a singular exception to the class of precious stones. This active obtrusion of observed coincidences upon all parallel cases, this active search for new particulars to have the observed properties thrust upon them, is one of the ways of extending the domain of knowledge. The inquirer has got in his hand a clue, and makes a business of following it out wherever he can find an opening; he has made his induction, and lies in wait for occasions of pushing it out into deductions. In this endeavour, his identifying faculty will avail him much; it will make him, as it were, keen-scented for everything in the memory of the past that bears a shadow of resemblance to his case; the recollections that, in an obtuse mind, would lie unawakened by the magnetism of similarity, in the mind of the other, start out one by one for examination and choice; and in this lies the harvest-home of the man of intellect.

We can next suppose the opposite case; given an obscure phenomenon, to illuminate it by bringing forward parallels or identities among phenomena that are clear and intelligible; it being supposed that such have actually occurred at some time or other, although in a connexion altogether remote from the present difficulty, so that only the force of similarity can bring them up. The position of the inquirer is now altered; nevertheless the intellectual operation is the same; to summon the clear, to illuminate the dark, or to summon the dark to be illuminated by the clear, must alike proceed on a felt identity, which identity is both the mental link of attraction, and the circumstance that justifies the transference of information from the one to the other. Of the instances already brought forward, several would correspond to this supposition; but, instead of recurring to these, I will cite the great identity made out by Franklin, between the thunder and lightning of the sky, and electricity, as shown on the common electrical machine. Next to the discovery of gravitation, this is perhaps the most remarkable fetch of remote identification that the history of science presents. The phenomenon of the thundery discharge was an exceedingly obscure and mysterious action; the natural obscurity of the case was farther increased by the emotions that it habitually inspired in men's minds, for nothing is more difficult than to identify, on a mere intellectual similarity, what excites deep emotions (especially fear) with what excites no emotion at all. Only a cool intellectual nature, such as distinguished Franklin, was a match for a case like this. He could face the evolution of a thunder-storm, and watch it with all the calmness that he would have shown in an ordinary philosophical experiment, deliberately bethinking himself the while of any parallel phenomenon wherewith he could identify and illustrate it. Had he lived a hundred years earlier, his attempt would have been in vain; for of all the scientific facts that could have crossed his view in the middle of the seventeenth century, there was no one that bore upon the case in hand, either obvious or remote. In the eighteenth century, his position was different; the electrical machine was a familiar instrument, and an intelligible account of its phenomena had been rendered; and these phenomena had been studied by Franklin, and were vividly impressed on his mind. To his cool eye gazing on the storm, the forked lightning identified itself (in the midst of a diversity that few minds could have broken through) with the spark of an electrical discharge. This was indeed the only feature of resemblance, unless a favourable accident had revealed some other coincidence, such as the existence of an electrical charge in the clouds before a storm ; and the identification must be ranked as a stroke of similarity to the very first order. It took all the preparation of an accurate study of the parallel subject of common electricity, with the passionless temperament and the strong intellect of Franklin, to achieve such a conquest over the obscurity that shrouds the atmospheric agencies. The identity once struck was duly verified, and proved to be a real and not a superficial or apparent sameness ; being, in fact, the same natural power showing itself in widely different situations. Then came all the *deductive* applications ; the circumstances known to accompany and precede the discharge of a Leyden jar could be transferred to the electrical storm ; the charging of the clouds with one electricity and the earth with an opposite, the increase of electrical tension to the pitch that an intervening insulator could no longer restrain, the shock of discharge,—were seen, through the medium of the familiar parallel, to be the history of the lightning and thunder of the sky. Every new fact, ascertained upon the machine, could thenceforth be extended to the electricity of the atmosphere ; what was not discoverable by examining this directly, could be known through the other, as a deductive inference.

The subject of electricity could furnish me with many other examples of scientific identification on a great scale, but my limits forbid me to dwell upon them.

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Analogy

37. Reasoning by *Analogy*. The three foregoing sections include three out of the four leading processes, or cardinal operations, of discovery. The remaining process, Observation, in one sense the foundation of the whole, does not depend directly upon the faculty we are now discussing. Every great step in science, exclusive of original observations, or experiments, is either an Abstraction, an Induction, or a Deduction But resort is occasionally had to Analogy, instead of identity. as a basis of Deduction or Inference ; and for our purpose of

illustrating similarity, the striking out of analogies is very much in point. As an example of analogical reasoning or inference, I may take the comparison of human society to a family, with the transfer of the duties and powers of the head of the family to the Sovereign of the state; this transfer is an inference or deduction, and is often tendered as a reason for the tutelary and despotical character of the Sovereign. The two cases are not identical; they possess an analogy, and a good reasoner remarks how far the analogy holds, and confines his inferences within those limits. In like manner, human society has suggested the analogy of herds and hives, a comparison much insisted on by Aristotle. A mind well stored with numerous conceptions, the fruit of various studies, and having at the same time a good reach of the identifying faculty, can strike out analogies when identities fail; and by means of these a certain amount of insight is sometimes obtainable. We have had occasion to advert to one remarkable scientific analogy, namely, that between nerve-force and common electricity, from which we have not hesitated to draw inferences, in order to support a certain view of the manner of working of the nervous system. Sometimes a farther investigation will convert an analogy into an identity, as was the case with gravitation—if it be true that Hooke came so near as to quote terrestrial gravity as an *illustration* of solar attraction; and as may be the case with Electricity and nerve force. But analogies, in the proper sense of the word, are similarities of relation in diversity of subject, as in the case of society above quoted, where the analogical character is the permanent fact. The circumstance of evolution attaching to the vegetable and animal kingdoms—the successive stages of birth, growth, and decay—is but an analogy as between a plant and an animal; to a still greater degree is this the case, when we are comparing the mental development of a human being with the growth of a tree, not to speak of the much more remote comparison between the growth of humanity, as a whole, and the progress of an individual animal, or plant. This last analogy is, indeed, too faint to be of any value, and is misleading if deductions are made from it. The logical caution that must accompany discoveries of supposed identity, is still more requisite in the slippery regions of analogy.

38. The exemplification now given of Similarity operating in Science, is a nearly complete account of the nature of the intellectual faculty called Reasoning. Some philosophers, as Reid and Stewart, have separated the mental processes concerned in Science into two—Abstraction and Reason. The one means the first of the three operations described above, the other, Reason, would be interpreted as covering Induction and Deduction. Sir W. Hamilton includes the whole under one head, variously named by him, the Elaborative, or Discursive Faculty, Comparison, the Faculty of Relations, and also Thought, in a certain narrow sense, as when Logic is defined 'the science of the laws of Thought.' In the detailed exposition, he divides the operations of the Faculty into two parts, corresponding to the common division, into Abstraction and Reason.—(Lectures on Metaphysics, ii. 277.) This seems to me the best view to take of the scientific faculty. As regards the mental forces concerned—the chief of these being Similarity—there is no essential difference between Abstraction on the one hand, and Induction, or Deduction, on the other; although the *products* are so far different, that it is convenient to illustrate them separately.

In remarking above, that Similarity does not explain the whole of the scientific faculty, I mean that Abstraction, Induction, and Deduction, frequently involve something besides the bringing together of resembling particulars or facts; what that something is, will be seen in the chapter on the Constructive operations of the Intellect.

BUSINESS AND PRACTICE.

39. In Business and Industry, in the power of intelligence applied to the affairs of life, in Practical Genius, we find exemplified the discovery of deep identities amid superficial differences. In the inventions of practical art, no less than

in the discoveries of science, the identifying faculty is called into play.

The labours of Watt, in the steam engine, might with great propriety be cited, to correspond with the greatest strokes of scientific indentification. Perhaps his 'governor balls' is the most illustrative example for our present purpose. Here he had to devise a method of opening and closing a valve, in connexion with the diminution or increase of the speed of a very rapid wheel movement; and no device in the range of existing machinery would answer this object. He had, therefore, to venture out into the region of mechanical possibility, to seek among mechanical laws in general, or among very remote natural phenomena, for a parallel situation; and he found the only case that has yet been hit upon, namely, the action of a centrifugal force, where two revolving bodies separate, or come together, according as the rate of revolution is accelerated or retarded. I am not aware of any stroke of remote identification in the history of mechanical invention, surpassing this in intellectual reach; if such a power of bringing together the like out of the unlike were of usual occurrence, the progress of discovery would be incalculably more rapid. Another instance of Watt's power of identifying a practical situation with some other case where the requisite construction is given, was the suggestion of a lobster-jointed pipe, for conveying water across the bottom of the river Clyde, and which answered perfectly. The inventive genius is ever ready with a suggestion derived from some already existing device disguised by considerable disparity, either in the arrangements of nature or in the constructions of art. Identifying power, although not expressing everything that constitutes an inventor, will be found a prominent feature in the character. As in the other departments, the identifying faculty must have a suitable region of previous acquisitions and experience to operate in.

In the able *administration* of private business and public affairs, we shall often be able to detect the same force at work, although it may not in this case be called invention or genius. Either in meeting new cases, or in bringing superior methods to bear upon old, there is a march of mind, an advance over routine, which marks the able administrator; and here too the link of power consists in a more than ordinary force of identification. When a present emergency is exactly like a previous one, it recalls that one without difficulty, and is treated as that was treated; when it corresponds exactly to no one previous, a subtler mind is wanted; a parallel must be sought for, away from the routine of cases. Into quite remote regions of affairs, the man of penetration is carried, and finds something in point where perhaps no parallel was ever drawn before. The application of the Syllogism to Law pleadings was a great legal improvement, which has persisted while scholastic forms have gone generally into decay. No routine lawyer was capable of such an innovation. If for illustration's sake we suppose it to have been the work of one person, it implies a mind that came to the study of law previously prepared with the scholastic training, and detecting in the pleadings before the courts a real identity in form with the discussions of the schools, although hitherto conducted with no such method or precision. The transference of the syllogism to the legal reasonings would be the consequence of this feeling of identity; and hence would arise that capital requirement of making parties plead to the law, and to the facts of the case separately, instead of huddling up both in one argument as is usually done in the controversies of everyday life.*

It is a usual circumstance for practical devices to be first employed in obvious cases, and thence transferred to other cases of a like nature but of more complexity. Thus in the

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* I am given to understand that the system of separating the law and the facts, in legal pleadings, did not arise as I suppose in the text, and as might have been the origin, from an application of the scholastic logic, but from our Saxon institution of trial by jury, where the facts were decided on by the jurors, and the law declared by the judge. Nevertheless, I consider the illustration good enough to be retained, even its hypothetical character.

great institution of the Division of Labour now so widely ramified over all departments of industry, a progressive application could be traced; we should find it commencing in manual industry, and in the separation of the primitive classes of agriculturist, artisan, trader, soldier, and priest; and thence, in later times especially, extended into the warehouse and the manufactory, into public business, and into scientific research. In every new step, there would arise, in the mind of some one person or other, a feeling of similarity between the exigencies of a business in hand and the cases where the method of divided labour was already in operation, and this identification would suggest the further extension of the practice. I do not at present speak of the faculty required for overcoming the difficulties of detail in all new applications of old machinery, (although here too it would be found, that a fertile power of recalling identities in diversity would be the principal instrument of success, in so far as the intellect was concerned,) I confine myself to the suggestion of a device taken from some parallel case.

In the progress of free governments, there has been gradually diffused, from the lower to the higher and more difficult posts, the principle of responsibility as a check upon the abuse of power. This practice grew up by a process of extension, until, in the constitutional governments of Great Britain and the United States, it came to include every executive officer in all departments of state. The experience of the practice, with the more humble functionaries, suggested its application to the exactly parallel case of superior officers, and after much struggle, not of an intellectual kind, it got to be introduced into modern free communities, as it had been in the constitution of ancient Athens.

The principle of non-interference with individual tastes and sentiments, except in so far as these affect the legitimate happiness of others, is recognized in certain cases, and has had a tendency to expand itself by assimilation into cases encumbered with obstructive circumstances. Hence has sprung up what amount of toleration in belief and conduct we now enjoy; although the difficulty in proceeding far with this extension, shows how effectually the love of domination and of uniformity may stifle the assimilating action of the intellect.

In the suggestions of a practical mind, the identification should always turn upon the *relevant* circumstances, and overcome other attractions of sameness on irrelevant points. To attain to this characteristic is the end of a practical education, which makes the person familiar with the aspects that serve the *ends* contemplated. Thus a lawyer in recovering, from his past experience, the precedents and analogies suitable to a case in hand, is impelled by the force of similarity working in his mind; but, of the many peculiarities of the case, he excludes the assimilating action of all except the one that would govern its decision before a judge. His education must serve him in making this discrimination; and if (as will happen) he is by natural temperament keenly alive to this one feature that constitutes legal relevancy, and indifferent to all other points of interest in the case, he is a born lawyer, just as Newton, with his natural avidity for mathematical relations and indifference to sensuous and poetic effects, was a born natural philosopher, or Milton, by the opposite character, was a born poet. That nature should chance to turn out a legal mind is not singular or surprising, for it is only a variety of the scientific or logical intellect, using verbal forms as the instrument, and implying an obtuseness to all the more popular and interesting features of human life. To secure a rigorous uniformity in dealing with disputes, scientific definitions must be made, and equally applied to the most diversified cases.

40. The last form of practical ability that I shall here advert to is *Persuasion*. This implies that some course of conduct shall be so described, or expressed, as to coincide, or be identified, with the active impulses of the individuals addressed, and thereby command their adoption of it by the force of their own natural dispositions. A leader of banditti has to deal with a class of persons whose ruling impulse is

plunder; and it becomes his business to show them that any scheme of his proposing will lead to this end. A people with an intense, overpowering patriotism, as the old Romans, can be acted on by proving that the interests of country are at stake. The fertile oratorical mind is one that can identify a case in hand with a great number of the strongest beliefs of an audience; and more especially with those that seem, at first sight, to have no connection with the point to be carried. The discovery of identity in diversity is never more called for, than in the attempts to move men to adopt some unwonted course of proceeding. When a new reform is introduced in the state, it is usually thought necessary (at least in England) to reconcile and identify it in many ways with the ancient venerated constitution, or with the prevailing maxims and modes of feeling with which it would seem at variance. To be a persuasive speaker, it is necessary to have vividly present to the view all the leading impulses and convictions of the persons addressed, and to be ready to catch at every point of identity between these and the propositions or projects presented for their adoption. The first-named qualification grows out of the experience and study of character; the other is the natural force of similarity, which has often been exemplified in its highest range in oratorical minds. In the speeches of Burke we see it working with remarkable vigour. Perhaps the most striking instance of this fertility of identification for persuasive ends is exhibited in Milton's *Defence of Unlicensed Printing*. Of the class of preachers, Barrow is especially copious in his command of topics of persuasion and inducement towards the performance of religious and moral duties; in him, no less than in Milton, we have everywhere the tokens of an identifying mind of the highest order.

ILLUSTRATIVE COMPARISONS AND LITERARY ART.

41. When two remote phenomena are brought into comparison by a flash of similarity, they may turn out to be repetitions of the same natural power working in different situations, as in the cases of lightning and the electrical dis-

charge, the fall of a stone and the moon's gravitation to the earth. The comparison in these cases is real or substantial. It is illustrative and instructive in no ordinary degree, but it is more than an illustration, it is a scientific discovery. The two things identified are so thoroughly of a piece, that we can go all lengths in reasoning from the one to the other. But there is also a useful class of comparisons where real identity is wanting; the likeness being yet sufficient to justify us in interpreting the more obscure and remote by the more intelligible and familiar of the two; as when, in speaking of the action of supply and demand in commerce, we say that these are constantly finding their level. Here the subjects compared are quite different in their nature, the one belonging of the province of mind, and somewhat obscure, while the other is a physical phenomenon of a very palpable and intelligible sort. Illustration after this fashion is one of our devices for representing to the mind what is either naturally obscure, or accidentally concealed from the view. If we can only see enough of the object to suggest an appropriate comparison, we make use of this to supply the rest. The force of similarity finds extensive scope in this department of discovery.

Illustration is particularly wanted to convey scientific notions and abstractions. These are often so artificial and abstruse, that an ordinary mind has great difficulty in seizing them. Such abstruse physical phenomena as the molecular constitution of matter, polarity, chemical affinity, the ethereal undulations supposed to constitute light and heat, the growth of cells in living bodies,—demand to be expressed by comparisons drawn from the seen and palpable. Human actions, feelings, and thoughts, are often so concealed in their workings, that they cannot be represented without the assistance of material objects used as comparisons; hence the great abundance of the resemblances struck between matter and mind. We speak of a clear head, a warm heart, a torrent of passion, a poet's fire. The comparisons brought to bear upon the complexities of social life are likewise very numerous; in-fact there are many social phenomena that we never conceive orherwise than in some matrix of material analogy. If we take, for example, the different ideas connected with social order and disorder, we find the language almost wholly derived from other things; scarcely a phrase is literal, all is metaphorical. 'The vessel of the state weathers the storm, or is in danger of wreck;' anarchy is described 'chaos,' 'confusion;' the government is said to be 'shaken,' or 'stable,' or 'tottering;' law is 'erected,' 'overthrown.' We speak of the 'life' and 'growth' of society; when we conceive of progress, it is generally in a figure; we call it 'movement,' 'development,' 'enlightenment,' and so forth.

Of all existing compositions, the writings of Lord Bacon are perhaps the richest in illustrative comparisons of the kind now under discussion; not being scientific identities, and yet serving in an eminent degree the purpose of assisting the popular intellect to embrace difficult notions. In virtue of this surprising power, Bacon's doctrines became clothed in 'winged words.' According to him, science is the 'interpretation' of nature; a comparison that transfixes the mind with the idea of observing, recording, and explaining the facts of the world. Final causes, he says, are 'vestal virgins;' they bear no fruit. But for the simile, it is doubtful if this notion would have stuck in men's minds and been the subject of keen controversy in the way that we have seen. His classification of 'Instances,' or forms of experiment and proof, is wholly embedded in strong metaphors; the 'experimentum crucis,' the leading post between two ways, has been adopted in every civilized tongue. Fallacies, or modes of mental bias, are with him 'idols' (*eidola*, false appearances) of the 'tribe,' of the 'den,' of the 'market-place,' of the 'theatre.'

A remarkably powerful identifying intellect, working upon the concrete facts of nature and human life and the history and literature of the past, is implied in this mode of genius, of which Bacon is the highest instance. The susceptibility to certain classes of objects and impressions determines the particular element that the resuscitating faculty must work in; and in some men this susceptibility is to the concrete in general, rather than to the select and narrow class of the artistic or poetic concrete. Thus, although Bacon's imagery sometimes rises to poetry, this is not its usual character; his was not a poetic sense of nature, but a broad general susceptiblility, partaking more of the natural historian than of the poet; by which all the objects coming before his view, or presented to his imagination, took a deep hold, and by the help of his intense attraction of similarity were recalled on the slightest similitude. Many great writers in English literature have had this strong susceptibility to the sensible world at large, without a special poetic sense; while some have had the poetic feeling superadded; these last are our greatest poets, Chaucer, Milton, Shakespeare.

42. This leads me to notice the second class of illustrative comparisons, those serving not for intellectual comprehension, but for ornament, effect, or emotion. I have said that Bacon's comparisons rarely grew out of a poetic choice, though from their reach, their aptness, and their occasional picturesqueness, they might sometimes be quoted as a kind of poetry. His purpose was to enlighten, not to adorn. But similarity is the instrument of adding ornament and force to compositions; when an idea or picture is intended to kindle emotion of any kind, the effect can always be heightened by adducing illustrative comparisons more impressive than the original. When Sir Philip Sydney, to describe the moving effect of the ballad of *Chevy Chase*, says that it stirs the heart 'like the sound of a trumpet,' he enforces a weaker impression by one much stronger as well as more familiar. The following lines of Chaucer contain two exquisite comparisons for enriching the emotional effect of the subject; it is part of his description of the youthful Squire.

> Embroided was he *as it were a mead,*
> *All full of freshè flourès white and rede;*
> He sung and fluted gayly all the day.
> *He was as fresh as is the month of May.*

To find powerful and touching comparisons in keeping with the original subject of the description, is one of the constant endeavours of the poet, and puts his genius to the severest test. But the same demand is made upon the orator, who has also to stir up the emotions of his audience, to kindle their likings and dislikings with a view of moving them in some one direction. Hence, in oratory of every kind, we find abundant use of the figures of speech growing out of comparison. In panegyric, elevating similitudes are employed, in denunciation, such as degrade. Derision and merriment grow out of low, grovelling comparisons applied to things pretending to be dignified and venerable. Burke's *French Revolution* teems with all the varieties of eloquent comparison. His 'trampling law and order 'under the hoofs of the swinish multitude,'' will be ever memorable among the figures of oratory.

Although Shakespeare often displays the Baconian power of illuminative comparison, especially in moral maxims and commonplaces, he shines chiefly in the other class, those that heighten the emotional effect (while the genius of both the one and the other abounds in such as have no effect whatever but intellectual profusion). With all his susceptibility to the sensible and concrete of the world, to the full face of nature and life, he had (although not in the *highest* measure) the poetic eclecticism, and dwelt by preference upon the objects that inspired emotions such as an artist is wont to kindle up. Having perhaps the greatest intellectual reach of similarity that the mind of man ever attained to, his power of adducing illustrative similitudes, through chasms of remoteness and the thickest disguise, will be a wonder and an astonishment to the latest posterity.

43. Of the Tropes and Figures described in Rhetoric, the largest half turn upon comparison. The metaphor, the simile, the allegory—are all forms of illustration by similitude, sometimes serving for clearness, or intellectual comprehension, at other times producing animation and effect. Their invention is due to the identifying intellect, which breaks through the partition, caused by difference of subject, to bring together what is similar in some one striking aspect or form. The literary and poetic genius of ages has accumulated a store of

such comparisons; many of them have passed into common speech to enrich the dialects of everyday life. No man has ever attained rank in literature, without possessing in some degree the power of original illustration; and the reach or interval of disparity through which new similes are brought, makes a fair measure of the intellectual force of the individual mind in one of the leading characteristics of genius. The original fetches of Homer, of Æschylus, of Milton, and above all of Shakespeare (I do not pretend to exhaust the list even of the first-rate minds), are prodigious. How remote, and yet how grand, the simile describing the descent of Apollo from Olympus: 'he came like night.' The identifying faculty, be it never so strong, would hardly suffice to bring together things so widely different, but for some previous preparation, serving to approximate the nature of the two things in the first instance, as we have already had occasion to remark of some of the scientific discoveries. Night itself had to be first personified to a certain extent, thereby reducing the immense disparity between the closing day and the march of a living personage down the mountain slopes. But with all due allowance for a high susceptibility of mind to the poetic aspects of things, the power of adducing comparisons from remote regions, such as we find it in the greatest literary compositions, is marvellous to contemplate.

THE FINE ART IN GENERAL.

44. The observations now made respecting Poetry apply with some modification to the Fine Arts generally. In the Arts we may trace out a scale or arrangement, beginning at the most intellectual and ending with those that have this quality in the lowest degree. At one end of the scale, we find distinct examples of the purely intellectual law of similarity; at the other end, scarcely a trace of this operation appears in the form that we have been accustomed to. Poetry, Painting, Sculpture, Architecture, Decoration, and Design, are all conversant with some of the higher intellectual elements: Poetry with speech and the pictorial as represented by speech,

the others with visual forms and appearances of various kinds. In storing up, and reproducing on fit occasions, the materials of those arts, the associating forces of Contiguity and Similarity are extensively brought into play. As to Contiguity, this is obvious enough ; as regards Similarity, it may be easily shown. A painter in composing a picture must, in the last resort, choose the component parts, according to their artistic keeping with one another : but in recalling from the past a number of objects, in order to try their effect, he will be greatly assisted by a powerful identifying faculty. We may suppose him to have in his mind some one plan of a background, which background, however, although containing the main features, does not satisfy his artistic sense. By the attraction of likeness, this part, unsuitable in itself, may recall others resembling and yet greatly differing, and in the array brought up by a powerful intellect, working upon a large foregone experience, some one may be presented answering the requirements of the picture. There may be nothing artistic in the suggestion of the different views ; nevertheless, it is only an artist that can make the proper choice. As in poetry, so in painting, in sculpture, in architecture, decoration, and design, there may be a rich intellectual storage and reproduction of the material, apart from the æsthetic feeling ; although, by this feeling, the artist must be guided in the use that he makes of the suggestions of the intellect. In all the Arts, examples may be found of rich profusion of unselected matter ; the authors mistaking a strong recollection and revival of natural scenery and pictorial elements in general for the artistic harmonizing of the material ; still, an Artist, in the class we are now discussing, cannot attain the highest greatness without some intellectual source of suggestions over and above his artistic faculty. The intervention of high intellect in Art seems to have reached a climax in Michael Angelo ; and the limits of human nature forbid us to suppose, that he could at the same time put forth the power of delicately adjusting the parts of his compositions, so as to yield the graces and charms that constitute the true distinction, the essence, of Art.

45. When we pass to the second class of Arts, we find intellect dying away and giving place to the genuine artistic stimulus in its purity. Music is the most conspicuous member of the group, and might be taken as representing the whole: the others are, spoken music or Eloquence, Dramatic action and pantomime, the graces of personal Demeanour and display, and the Dance. In these Arts, the suggestions of intellectual similarity can hardly be said to occur. Undoubtedly, we may by similarity, as already said, identify a common character in different airs and harmonies; and, through the presence of any one, others may be recalled to the mind of a composer, and may serve him as hints and aids in a new composition. In such circumstances, I can conceive the operation of a vigorous identifying faculty as enlarging a musician's resources, or making more readily available to him the examples that have previously impressed themselves on his mind. But this process of imitating and compiling does not fairly exemplify the workings of artistic creativeness. The author of a truly original melody relies upon no such intellectual assistance. By the spontaneous gushings of his mind he flows out into song, and by the guidance of a delicate sense he tunes himself to melody. Other men may imitate and combine such primitive originals in a variety of compositions, but the knowing ear can always detect the work of compilation. Intellect may originate Science, but not Art. It might be shown, I believe, that the fountain of artistic originality, in such instances as music and dramatic action, is to be sought in the emotional and spontaneous workings of the organs; while, in the compositions of the foregoing class, these workings conspire with the sensuous intellect; and, in all alike, a keen æsthetic sensibility is indispensable.

I may here refer to what is a common subject of remark, that great musicians and actors, not to speak of opera dancers, have often a very low order of intellect, as measured by the ordinary tests. So, in the charms and graces of society, which are a species of fine art, intellect may contribute nothing. In assisting the less gifted temperaments to take on the charm native to the others, it may operate with good effect; for this is done by acquisition and compilation, where the intellectual forces always work to advantage. Moreover, in Art, effects can often be reduced to rule, and the comprehending and following out of rules is an affair of the intelligence. In musical compositions, there are rules as to harmony, which any one might act upon; in elocution, much can be done by merely understanding the directions of an instructor, but, to stupidity, all such directions are nugatory. Thus it is, that in the diffusion and extension of the least intellectual of the fine arts, recourse may be had to an instrumentality that would never suffice for their creation. It is a remarkable fact in history, that the most highly gifted people of antiquity, in all that regarded pure intelligence, had apparently no originality in music, although they could appreciate and borrow the melodies of foreign nations, and employ these to accompany their lyric and dramatic compositions.

SIMILARITY IN ACQUISITION AND MEMORY.

46. It now remains to show how the force of reinstatement by Similarity can operate in carrying forward the work of Acquisition. We have seen that the associating principle of Contiguity must needs be the groundwork of Acquisition in general; but when any new train can bring up, from the past, some nearly similar train, the labour of a separate acquirement is thereby saved; the points of difference between the new and the old, are all that is left for Contiguity to build up in the mental system. When a workman is to be taught a new operation in his art, there will necessarily be, along with certain matters of novelty, a large amount of identity with his already acquired habits; hence, in order to master the operation, he will require to repeat it just as often as will suffice for fixing, by the plastic operation of Contiguity, all those new steps and combinations. A professed dancer learning a new dance, is in a very different predicament from a beginner in the art. A musician learning a new piece, actually finds that nineteen-twentieths of all the sequences to be acquired have

been already formed through his previous education. A naturalist reads the description of a newly discovered animal; he possesses already, in his mind, the characters of the known animals most nearly approaching to it; and, if he merely give sufficient time and attention for fastening the features that are absolutely new to him, he carries away and retains the whole. The judge, in listening to a law-pleading, hears little that is absolutely new; if he keeps that little in his memory, he stores up the whole case. When we read a book on a subject already familiar to us, we can reproduce the entire work, at the expense of labour requisite to remember the additions it makes to our previous stock of knowledge. So in Fine Art; an architect, a painter, or a poet, can easily carry away with them the total impression of a building, a picture, or a poem; for, instead of being acquisitions *de novo,* they are merely variations of effects already engrained on the artist's recollection.

To whatever extent one thing is the repetition of another, the cost of contiguous acquisition is saved. But it is necessary that the repetition or identity should be perceived; in other words, the new lesson must reinstate, by the force of similarity, all the previous trains that in any way correspond with it. An old acquirement containing many steps in common with a lesson in hand, will be of no use unless it is recalled; should the disagreeing points be so marked, as to cloud the resemblance and stifle the identifying action, nothing is gained by the agreement. It consequently happens, that a mind, feeble as regards the restoring force of similarity, misses the help that past acquirements could often bring to bear upon present effects; whereas a remarkable energy of recall will make everything available that contains the smallest trace of common matter.

47. To take a few examples from Science. The subject-matter of Geometry embodies a few fundamental notions and processes. A definition, an axiom, a postulate, a proposition, whether theorem or problem, a chain of demonstration, are to the beginner things absolutely new. They must be fixed by

the plastic power of Contiguity, and time and concentration must be allowed for the purpose. But, in a good head, one or two examples of each strongly imprinted will make all the rest easy ; the method or *character* of the devices will be seen through and acquired, and, in every new case, the mind will fall back upon the old ones, for the common element, and concentrate attention on the points of difference solely. When, after going over a few definitions, the mind gets impressed with the form and peculiarity of a definition, there is little to acquire in the rest; a slight substitution serves to make a new one out of an old; the definition of a square is easily changed to suit a rectangle. So with an axiom: the first is the most laborious to acquire; every subsequent one is easier than the preceding. When we come to the propositions, there is a very great deal of novelty at first; the whole scheme and management of a theorem or problem—the formality in the statement, and in the order of the proof—are things utterly strange to the young beginner; to acquire a simple proposition is a heavy strain upon his adhesiveness for abstract and representative forms. When this last acquisition is made, it can be turned to account in every succeeding proposition, provided the operation of similarity is not obstructed by the differences that encumber the new cases. Indeed, if each step in the machinery of Geometry were, without much waste of time, firmly learned on the first encounter, and if the reviving power of similarity for this class of things were unfailing, one's progress through Euclid would be a race, such as is recorded of Pascal and Newton. But to the generality of minds, identities in geometrical reasoning are hard to perceive; a difference in collaterals utterly extinguishes the sense of a similarity in substance, and every new proposition is a fresh labour, as if nothing like it had been gone through before.

What is true of Geometry holds in all the sciences. There is in each one a vast deal of repetition both of the facts, or subject-matter, and of the formal machinery, although with great differences of mode and circumstance. The law of gravitation runs through all Astronomy; and, in the deepest calculations of the celestial movements, the same mathematical devices are constantly reproduced in new complications. A mind that can seize a calculation once for all, and trace it out in the thickest envelope of diversity, will speedily pass through the intricacies of this vast subject, or of any abstract science. With such a reach of similarity as can suffice to trace out identities hitherto passed over by all former minds working in the same sphere, it is to be presumed that the more ordinary resemblances will be easy to strike; hence an original mind in science is also distinguished for the rapidity of its course, along the track of the already known. Much of the acquisitions of a strong intellect are in reality the re-discovery of what is already known; such an intellect perceives the identities of abstraction, classification, induction, deductive application, and demonstrative reasoning, even before they are pointed out by the master. He will make but a poor mathematician that needs to refer to his book for the demonstration of every successive theorem. With all branches of Physics, with Chemistry and Physiology, the very same remarks will apply. It is the nature of an advanced science, to contain innumerable identifications summed up in its definitions and general laws; it was by a vigorous similarity that these were first formed; by the same power they are rapidly acquired.

So in the more concrete sciences of the Natural History group. In Zoology, Botany, Mineralogy, Geology, there has been accumulated a fund of identities in the classifications made of the objects of each. To acquire these classifications, the learner must himself feel the similarity among the individuals; and if his mind is of that powerful kind that can trace many of the likenesses by its own unassisted force, he will speedily string together all the groups that have been formed by others. It is of consequence to a botanist, looking to a new plant, that he shall be able to recall at once whatever other plants he had known that in any way resemble it; he will, in this way, both determine its true class, and stamp it with ease upon his memory.

48. In all the acquisitions of Business, Similarity will likewise bear an important part. If an apprentice at the Law has that deep and subtle identifying power that sees, in every new case, whatever similarity there is in it to some previous one, he saves half his labour; his mind breaks in upon the old track, and on that builds up the new recollection to the extent of the likeness. It is possible to lay under contribution in this way matters quite different from the subject in hand; one may clench the technicalities of the law, by falling back upon one's miscellaneous knowledge; we may recur to recollections out of all sciences and arts, illustrating the subject as it were to one's self. The mind of Lord Bacon could see in anything before him multifarious analogies to things the most remote; these analogies he could produce to his readers to facilitate their conception of his meaning, and, by the same power, he could shorten his own labour and study. When a clever person surprises us, by instantaneously comprehending and firmly retaining some new method of procedure, we may be quite sure that it has taken hold of him, by resuscitating something analogous out of the storehouses of his past experience; whenever this easy comprehension, and this permanent retention, form part of the mental character, and show themselves in a wide range of subjects, a vigorous identifying faculty certainly lies at the bottom.

49. The case of the Artistic mind presents no essential difference. The storing up of impressions of objects of art is easiest, when the identifying power is so strong as to bring up, on every occasion, whatever resembles the object before the view. That a likeness should exist between something we are at present looking at, or listening to, and some past impressions on the eye or the ear, and that that likeness should not be felt, is a misfortune, a loss in every way; and for this reason among others, that, to impress the new object on the memory, we require as much repetition and pains, as if nothing of the kind had ever been experienced before. In reading a poem, the memory is assisted to remember it by all

the similarities of thought, of imagery, of language, of metre and rhythm, that one is able to evoke from the traces of former readings and recollections. In a mind keenly susceptible on all these poetic elements, and having the power of similarity highly manifested, almost every touch will rouse up something from the past that has a certain degree of resemblance, and that something will be an already formed recollection, to eke out the retentiveness of the new strain. The more one's acquisitions advance, the greater the scope for this work of fitting old cloth into new garments ; but previous acquisition is of avail only according as the stroke of resuscitation is good, and able to pierce the disguises of diversity and altered form attaching to past examples.

50. The retentive power of the mind is not thoroughly tested, except by entire and absolute novelty, a thing that is more and more rare as one grows older. In learning languages, for example, we have less to acquire with every new individual language. Latin prepares for French, Italian, Spanish, &c. ; German for Dutch ; Sanscrit for Hindostanee. The generalizations of philologists in tracing common roots through all the Indo-European tongues, greatly diminish the number of original ties that contiguity has to fix. All discoveries of generalization have this effect ; and if an individual learner can see likenesses, in addition to what have been already promulgated, his labour is shortened by strokes of power peculiar to himself.

51. The historical Memory might furnish good examples of the intervention of Similarity, in making up the coherent tissue of recollected events. In the transactions of the world, great and small, there is so much of repetition, that a new history is in reality a various reading of some old one ; not to mention how much each nation repeats itself through its successive epochs. To a dull mind, a great deal of this repetition is lost for all purposes, the aid to memory among the rest ; but a keen-sighted attraction for every vestige of recurring likeness enables one to retain large masses of narrative, at a small expense of adhesive acquisition. Campaign sug-

gests campaign, and one battle another; an intrigue, a negotiation, a career of ambition, a conquest, a revolution, are no new things to the student gone some way in history; certain minor features, some of the proportions and circumstantials, are special to the case in hand, and these must be fixed in the memory by pure contiguity. No man could recite a narrative of any sort from a single reading or hearing, if it were all new to him; to tell a story, an hour after hearing it, would be impossible, but for our already possessing, among our stored recollections, more than nine-tenths of all the adhesions that enter into it.*

* If we were to seek for a Physiological foundation of the Law of Similarity, we might find it in such considerations as these. The fact that we have gone through a certain operation, mental or bodily, makes us disposed to do the same again; this is the meaning of retentiveness or plasticity. Everything that we have ever done, we have a disposition or tendency to repeat; but usually the disposition is too feeble to assert itself freely, without some aiding circumstances. The co-existence of thousands of such tendencies in the brain is sufficient to cause neutrality, until something occurs to determine a preference for one, or to remove the superincumbent pressure that all combined exert upon each. Now the existence of a present state formerly joined by contiguity to a past state, is one mode of opening up the crowd to allow this past state to re-assert itself. The other mode is when the past state is already *partially induced*, which is the case when something similar is present to the mind. To whatever extent the similarity holds, to that extent the past state is already re-enacted: the pressure is removed from a part, and the remainder is then able to break out.

CHAPTER III.

COMPOUND ASSOCIATIONS.

1. HITHERTO we have restricted our attention to single threads or indivisible links of association, whether of Contiguity or Similarity. It remains for us yet to consider the case where several threads, or a Plurality of links or bonds of connection, concur in reviving some previous thought or mental state. No new principle is introduced here; we have merely to note, what seems an almost unavoidable effect of the combined action, that the reinstatement is thereby made more easy and certain. Associations that are individually too weak, to operate the revival of a past idea, may succeed by acting together; and there is thus opened up to our view, a means of aiding our recollection, or invention, when the one thread in hand is too feeble to effect a desired recall. It happens, in fact, that, in a very large number of our mental transitions, a multiple bond of association is at work, and our subject therefore demands that we should follow out the exposition under this new case.

The combinations may be made up of contiguities alone, of similarities alone, or of contiguity and similarity mixed. Moreover, we shall find that there is a suggesting power in Emotion and in Volition, and that this may conspire with the proper intellectual forces, and may either assist or obstruct their operation. In the reviving of a past image or idea, it is never an unimportant circumstance, that the revival gratifies a favourite emotion, or is strongly willed in the pursuit of an end. We must endeavour to appreciate, as far as we are able, the influence of these extra-intellectual energies within the sphere of intellect; but, as they would rarely suffice for the reproduction of thought, if acting apart and alone, we are led to look at them chiefly as modifying the effects of the proper intellectual forces, or as combining elements in the composition of associations.

The general law may be stated as follows :—

> Past actions, sensations, thoughts, or emotions, are recalled more easily, when associated either through contiguity or similarity, with more than one present object or impression,

COMPOSITION OF CONTIGUITIES.

2. Commencing with the case where a plurality of links of contiguous association is concerned in the revival, there is a wide scope for illustration. Instances might be cited under all the heads of the first chapter ; but a less profuse selection will suffice. There will, however, be a gain in clearnesss by taking Conjunctions and Successions separately.

Conjunctions.—For a simple example of a compound conjunction, we may suppose a person smelling a liquid and identifying the smell as something felt before, but unable to recall to mind the material causing it. Here the bond between an odour and the odorous substance is too feeble for reproducing the idea and name of the substance. Suppose farther that the person could taste the liquid without feeling the odour, and that in the taste he could recognize a former taste, but could not remember the thing. If, in these circumstances, the concurrence of the two present sensations of taste and smell brought the substance to the recollection, we should have a true instance of composite association. If one of the two links is fully equal to the restoring effect, there is no clear case under the present law ; in order to constitute a proper example, each should be insufficient when acting singly.* There can, I think, be little doubt as to the fact that such

* If, by the assistance of the second bond, the revived idea were more *vividly* or forcibly brought forward, we should have a true example of compound association, although a restoration was possible through the first bond acting alone.

revivals occur, although we might conceive it otherwise, It would be nothing intrinsically improbable that two links of connexion inadequate separately, should be inadequate jointly; just as no amount of water at the temperature of 40° is able to yield one spoonful at 45°. Combination does not in all cases make strength. Ten thousand commonplace intellects would not make one genius, under any system of co-operation. The multiplication of unaided eyes could never equal the vision of one person with a telescope, or microscope.

We have seen that the *complex wholes* that surround us in the world, are held together in the recollection by the adhesive force of Contiguity; such objects as a tree, a human figure, a scene in nature, cannot continue in the mind, or be revived as ideas, until frequent repetition has made all the parts coherent. After the requisite iteration, a complex object, such as a rural village, may be revived by the presence of a single portion of it, as some street, or building, or marked locality. But if the village is one not well known to a person, that is, if the notion of it is not very firmly aggregated in the mind, the traveller just entering may be not liable to identify it by the first thing that strikes him; he may require to go on till several other objects come in view, when probably their joint impression will be able to bring up the whole, in other words, will remind him what village he is now entering.

So in regarding objects as *concretes*, or combinations of many distinct qualities,—an orange, for example, affects all the senses,—there is a fixing process which makes the different sensations hold together in one complex idea. Here, too, there is room for the joint action of associating links in recalling an image to the mind. I have already imagined a case of this description, where the united action of smell and taste was supposed to revive the idea of the concrete object causing them, either being of itself insufficient for the purpose.

3. It is, however, when we go beyond the case of isolated objects, to the still greater aggregations made up by the relations of things to one another, that we can reap examples of multiple association in the greatest abundance. In the con-

nexions of objects with places or locality, with persons, with uses, and with all the properties that may belong to them, we see numberless occasions for the working of the composite link in effecting the recall.

When things have a fixed *locality*, they become associated in the mind with that locality, or with a number of companion objects or appearances. This is one of the means of their restoration to the mind in idea. The sight or remembrance of a harbour recalls the shipping; the recollection of a building brings up the things that we know it to contain. Conversely, an object that has a fixed place recalls the place, as when St. Paul's reminds us of the neighbourhood where it stands. Now it not seldom happens, that we desire to recall a place or an object by this link of connexion, but are unable to do so; a second connexion of this, or of some other kind may then come to the rescue.

Thus, to take the case of searching for things lost. When we do not know where to find a thing, although we ourselves have put it in its place or seen it there, the adhesion of place is by that circumstance declared to be feeble. We then run over other links of association; we get upon the time when we last saw it, the work we were engaged in, or any fact that would, along with the lost object, have an association with the forgotten place, and we may thus, through a multiplicity of feeble connexions, attain a force of recall equal to one strong adhesion.

The connexions with *persons* frequently yield an assisting link in difficult recollection. Objects become associated with their owners, their makers, inventors, all persons concerned in their use, or frequenting their locality. When we are unable to recover a thing, by the adhesion between it and other inanimate accompaniments, the suggestion of a personal connexion will often make up what is wanting in reviving efficacy. Thus, in my endeavour to recollect an array of objects in some museum, there are some that have completely escaped me; the association of these with their place in the building, and with the adjoining objects which are present to my mind, is not enough; but when I chance to recall the donor, the collector, or maker, along with these other adjuncts, the vanished individuals will probably reappear.

It happens likewise that things are recalled by plurality of association with persons, each link being too weak alone, but made powerful by union. I meet some one in the street, and make an ineffectual attempt to remember where I last saw the same person : by and bye some one else occurs to me, who was present in the same place. Perhaps, if I had merely this last person in my view, I should have been as little able to revive the place as with the first alone ; whereas with the two, I have no longer any difficulty.

The converse operation of remembering a person by two or more different connexions is still more frequently exemplified. A human being is a sufficiently many-sided object to be open to revival through a multiplex bond. Looking upon it, either as an aggregate of many parts, or as a concrete of many qualities, the remark holds to a great degree. The particulars of a personal description are very numerous, and it often requires many of them to be cited, in order to bring to mind an individual very well known to us. Moreover, the external relations of human beings surpass in variety those of other objects. Persons are associated with their name ; with locality, habitation, and places of resort ; with blood and lineage, a very powerful mental tie in consequence of the strength of the family feelings; with associates and friends ; with occupation, pursuits, amusements ; with property and possessions ; with rank and position ; with the many attributes that make up character and reputation ; with a particular age ; with the time they have lived in ; with the vicissitudes and incidents that mark the course of their life. Now, in recalling some individual to mind, any one or more of these connexions may serve us ; and when a present link is insufficient, others require to be added. If we were endeavouring to recover the historical personages of a given time, the age of Pericles, for example, there would be a certain strength of bond between each of them and the idea of the time, namely, the fifth century before Christ. In the case of some, this link might be strong enough of itself; with others, a second link might be requisite, as for instance, their profession. With the idea of a sculptor entering into the composition, we should recall Phidias, with a painter, Zeuxis, with a philosopher, Anaxagoras. Our historical memory is very often helped after this fashion.

4. The connexion of things with *uses* is a source of multiple bonds. A tool, a building, the materials of food, clothing, &c., everything that comes into the market as a useful commodity, an army, or a fleet,—all such things have besides their appearance, locality, ownership, &c., a distinct end to serve, whence arises a powerful bond of association. If I am unable to remember the objects that I have seen in a certain shop, by virtue solely of their association with the shop, and with contiguous things that I do remember, one course open to me would be to run over in my mind a list of utilities to be answered, in which list I should bring up one or more uses of the forgotten things, and this new bond co-operating would be sure to recover some of those from their oblivious condition. To carry away a full recollection of the contents of a manufactory that I have visited, I should find it necessary to aid the association of contiguity of place and succession, with the various ends or utilities that were to be supplied.

In the natural sciences, the material objects of the world are looked upon as having many *properties*, useful or not; these are ascertained by observation and experiment, and are recorded as part of the description of the several substances. In this way, everything suffers an ideal expansion or aggrandizement in the mind; the connexions of things, or the threads that give us our hold of them, are multiplied. The substance, Silica, in the mind of a naturalist, has a vast range of associations in consequence of the many properties entering into his notion of it. These various links tend to bring the substance repeatedly before the mind; sometimes one link is sufficiently powerful, for example, the recollection of a given degree of hardness; at other times, the material is recovered by double or triple connexions, as the ideas of an oxide, of insolubility, and of a six-sided crystallization. The scientific man's memory is constantly liable to be aided by the multiplication of bonds individually too feeble to bring about the recollection of a forgotten object. In invention, or in the search for a new device to answer some end, the mind must go over catalogues of objects according to many kinds of contiguity, including the most casual connexions.

5. *Successions.* I have dwelt at length, in a previous chapter, on the contiguous association of successions of various kinds. Here, too, in the case of imperfect adhesion, the recovery may be due to a composite action. I have witnessed a series of events, and these are, in consequence associated in my mind. In endeavouring to recall the series from the commencement, a link fails, until some other association, such as place, or person, contributes an assisting thread.

There is one succession that contains the whole of our experience, that is, the Order of Time, or the sequence of events in each one's own history. If all the minutiæ of this succession were to cohere perfectly in the mind, everything that we have ever done, seen, or been cognizant of, could be recovered by means of it. But although all the larger transactions, and the more impressive scenes, of our personal history are linked in this order with a sufficient firmness, yet for smaller incidents the bond is too weak. I cannot remember fully my yesterday's train of thoughts; nor repeat verbatim an address of five minutes' length, whether spoken or heard. Things related in the order of time are, strictly speaking, experienced only once, and we usually require repetition to fix any mental train. It constantly happens, therefore, that we are in search of some reinforcing connexion to help us in recovering the stream of events, as they occurred in the order of time. We seek for other conjunctions and successions to enable us to recommence after every break.

Experience teaches us, that the only way of making up a defective adhesion is to compass in our minds some other connexion, or to get at the missing object through a new door. The inability to recollect the next occurring particular of a train that we are in want of, stimulates a great effort of volition, and the true course for the mind to take is to get upon some chain or stream that is likely to cross the line of the first near the break.

At every moment of life, each person stands immersed in a complicated scene, and each object of this scene may become a starting point for a train of recollections. All the internal feelings of the body ; everything that surrounds us and strikes the eye, ear, touch, taste, or smell ; all the ideas, emotions, and purposes occupying the mind ;—these form so many beginnings of trains of association passing far away into the remotest regions of recollection and thought ; and we have it in our power to stop and change the direction as often as we please. From some one of these present things, we must commence our outgoings towards the absent and the distant, whether treading in single routes, or using the aid that composite action can bestow.

6. *Language.*—The recall of names by things, and of things by names, give occasion for bringing in additional links to aid a feeble tie. When we have forgotten the name of a person, or of an object, we are under the necessity of referring back to the situation and circumstances where we have heard the name, to see if any other bond of connexion will spring up. Often we are unable at the moment to recover the lost sound by any means ; but, a short time afterwards, an auxiliary circumstance crosses the view, and the revival is effected.

Many of our recollections, thoughts, conceptions, and imaginings, are an inextricable mixture of language and ideas of things. The notions that we acquire through oral instruction, or from books, are made up in part by the subject matter purely, and in part by the phraseology that conveyed it. Thus, my recollection of a portion of history is made up of the train of words, and the train of historical facts and scenes, as I might have seen them with my own eyes. So in many sciences, there is a combination of visible or tangible notions with language. Geometry is a compound of visible diagrams with the language of definitions, axioms, and demonstrations. Now, in all these cases, recollection may turn, either on the associations of words, or on those of visible and other conceptions, or on a compound of both. If I listen to a geographical description, there is, in the first place, a train of words dropping on my ear; and by virtue of a perfect verbal cohesion I might recall the whole description and recite it to another party. In the second place, there is a series of views of objects—of mountain, river, plain, and forest—which I picture in my mind and retain independently of the language used to suggest them. Were my pictorial adhesion strong enough, I could recall the whole of the features in the order that I was made to conceive them, and leave aside the language. The common case, however, is that the recollection is made out of a union of both the threads of cohesion; the pictorial train is assisted by the verbal, and the verbal by the pictorial, as may be required.

COMPOSITION OF SIMILARITIES.

7. The effect of the multiplication of points of likeness, in securing the revival of a past object, is liable to no uncertainty. It is only an extension of the principle maintained all through the discussion of the law of similarity, that the greater the similitude, and the more numerous the points of resemblance, the surer is the stroke of recall. If I meet a person very like some one else I have formerly known, the probability of my recalling this last person to view is increased, if the likeness in face and feature is combined with similarity of dress, of speech, of gait, or of any still more extraneous points, such as occupation, or history. Increase of resemblance *extensively*, that is by outward connexions, has the same power as increase of resemblance *intensively*, in rendering the restoration of the past more certain. It might admit of a doubt whether four faint links of contiguous adhesion would be equal to one strong, but it would be against our whole experience of the workings of similarity, to doubt the utility of multiplying faint resemblances, when there was no one sufficiently powerful to effect the revival. At the same time, we must admit that much more is contributed to the chances of

reinstatement by intensifying one point of likeness, than by adding new ones of a faint character. By raising some single feature almost up to the point of identity we should do more good than could be done by scattering faint and detached likenesses over the picture. This, however, is not always in our power; and we are fain to acknowledge, that, when the similarity, in any one particular, is too feeble to suggest the resembling past, the existence of a plurality of weak resemblances will be the equivalent of a single stronger one.

On this view, I might exemplify the workings of composite similarities, from the various classes of examples gone over in the preceding chapter. In all very complicated conjunctions as, for example, a landscape, there may be a multiplication of, likenesses, unable to strike singly, but, by their concurrence suggesting a parallel scene. Hence, in endeavouring to recall resembling things, we may proceed, as in Contiguity, by hunting out new collaterals, on the chance of increasing the amount of similitude, and, with that, the attractive power of the present for the absent. If I am endeavouring to recall to mind some historic parallel to a present political situation, supposing one to exist and to have been at some former time impressed on my mind, there may be a want of any single salient likeness, such as we admit to be the most effective medium of reinstatement; and I must, therefore, go over in my mind all the minute features of the present, to enhance, in this way, the force of the attraction of similitude for the forgotten parallel.

8. The case noticed at the conclusion of the preceeding head, namely, the combination of language with subject-matter in a mixed recollection, is favourable to the occurrence of compound similarity. If an orator has to deal with a special matter, the conduct of an individual, for example, which he wishes to denounce by a cutting simile, his invention may be aided by some similarity in the phrases descriptive of the case, as well as in the features of the case itself. If one who has at a former time read the play of Œdipus, now commences to read Lear, the similarity is not at first apparent, but long before the conclusion there will be a sufficient

accumulation of features of similitude, in dramatic situation and in language, to bring Œdipus to mind without any very powerful stretch of intellectual force. So, in scientific invention; a fact described in language has a double power of suggestion; and if, by good luck, both the fact and the description have a resemblance to some other fact, and to the language that accompanied that other when formerly present to the mind, there is so much the more chance of the revival taking place.

MIXED CONTIGUITY AND SIMILARITY.

9. Under this head several important groups of instances might be noted.

If any one, in describing a storm, employ the phrase 'a war of elements,' the metaphor has been brought to mind partly by similitude, but partly also by contiguity, seeing that the comparison has already been used in conjunction with the picture of a storm. The person that first used the phrase came upon it by similarity; he that used it next had contiguity to assist him; and, after frequent repetition, the bond of contiguity might come to be so well confirmed, that the force of similarity is at last entirely superseded. In this way, many things that were originally strokes of genius, end in being efforts of mere adhesive recollection; while, for a time previous to this final consummation, a mixed effort of the two suggesting forces is displayed. Hence Johnson's remark on the poet Ogilvie, that his poem contained what was once imagination, but in him had come to be memory.*

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* 'On Tuesday the 5th July (1763), I again visited Johnson. He told me he had now looked into the poems of a pretty voluminous writer, Mr. (now Dr.) John Ogilvie, one of the Presbyterian ministers of Scotland, which had lately come out, but could find nothing in them.

'BOSWELL. 'Is there not imagination in them, Sir?'

'JOHNSON. 'Why, Sir, there is in them, what *was* imagination, but it is no more imagination in *him*, than sound is sound in the echo. And his diction, too, is not his own. We have long ago seen *white-robed innocence*, and *flower-bespangled meads*.''

In all regions of intellectual exertion—industry, science, art, literature, there is a kind of ability displayed in taking up great and original ideas and combinations, before they have been made easy by iteration. Minds unable for the highest efforts of origination may yet be equal to this second degree of genius, wherein a considerable force of similarity is assisted by a small thread of contiguity. To master a large multitude of the discoveries of identification, a power of similarity somewhat short of the original force that gave birth to them, is aided by the contiguous bond that has grown up, during the few repetitions of each that there has been opportunity for making.

10. A second case is, when a similarity is struck out in circumstances that brought the absent object into near *proximity* in some contiguous train. Thus a poet falls upon a beautiful metaphor, while dwelling in the region, or neighbourhood, where the material of the simile occurs. In the country, rural comparisons are most easily made; on shipboard, nautical metaphors are naturally abundant. There is a real effort of similarity in giving birth to new comparisons, but the things compared may happen to stand so near, that, notwithstanding a considerable degree of faintness or disguise, the embrace of identity comes on.

If we chance to be studying by turns two different sciences that throw much light on each other, we are in a good way for easily deriving the benefit of the comparison. When we know the most likely source of fertile similitudes for some difficult problem, we naturally keep near that source, in order that we may be struck with the faintest gleam of likeness, through the help of proximity. A historian of the ancient republics keeps his mind familiar with all the living instances of the republican system, as well as with those of the middle ages that have been fully recorded. At a period when physical science is largely indebted to mathematical handling, as during the age of Newton, the scientific man spends half his time in mathematical studies. In such cases it is not safe to trust to an acquisition of old date, however pertinacious the mind be in retaining the subject in question. The great discoveries of identification that astonish the world and open up new vistas of knowledge, may have often required a help, from the accidental proximity of the things made to flash together. For illustration's sake, we might suppose Newton in the act of meditating upon the planetary attraction, at the time that the celebrated apple fell to the ground before his eyes; a proximity so very close would powerfully aid in bringing on the stroke of identification.*

THE ELEMENT OF FEELING.

11. We have already seen, under Contiguity, that associations grow up between objects and emotional states, whereby the one can recall the other—the object reviving the emotion, and the emotion the object. Anything, for example, that has been strongly associated with a disgust, is apt to recall the feeling at a future time.

This link may now be noted as entering into composite associations. In remembring some past object that has been linked in the mind with a certain emotion, the presence of the emotion will contribute to the recall. Although perhaps insufficient of itself, this bond will often be found co-operating with others to effect the revival of an old recollection. While luxuriating in a state of agreeable warmth, we are easily reminded of former situations and circumstances that have had this accompaniment.

Dr. Pick, a public lecturer on Mnemonics, has suggested an aid to verbal memory, founded on compound association. If we are learning a string of unconnected names, we must trust to contiguous growth solely; but, if it be allowable to arrange them at pleasure, Dr. Pick suggests that we should find out an order, such that each word shall have in it something in common with the following, or some pre-established connection of meaning. Thus, he takes the French irregular verbs, and arranges them in the following series :—(I give the English) sew, sit down, move, go, go away, send, follow, run, shun, &c. The previous association between the actions expressed by 'sew' and 'sit down' is obviously a powerful addition to the link of mere contiguity in utterance. Alphabetical arrangement gives a similar aid, although not so efficacious as the close alliance of meaning that occurs in the above series.

When the mind is immersed in any of the special emotions, as Terror, Anger, Tenderness, Beauty, objects connected with the emotion are favoured, while all others are repelled. In moods of tenderness, objects of affection rise by preference; this link co-operating with any other that may be present makes the restoration of such objects more certain. If the mind is disposed to indulge in the irascible emotion, objects of anger and hatred find an easy opening, while others are repelled even although strongly suggested by other links of association. Something occurs to remind a person of a good deed performed to him by the object of his wrath; but the recollection is refused admittance. When an emotion possesses the mind in anything like fury, nothing that discords with it can find a place, though never so powerfully suggested, while the feeblest link of connexion is sufficient to recall circumstances in harmony with the dominent state.

12. Hence in minds very susceptible to emotion, the more purely intellectual bonds of association are continually combined and modified by connexions with feeling. The entire current of thought and recollection is thus impressed with a character derived from emotion. Where tender affection is indulged as a dominant feeling, the objects that rise from the past, no less than those engaging the attention in the present, are for the most part tinged with this feeling. A joyous temperament has its genial recollections; melancholy opens the door to a totally different class. The egotist is eager for any suggestions that connect themselves with self, and a slight contiguity or similarity will suffice to make these present. Poetic emotion, gaining possession of the mind, gives a select character to the images that recur from the past. A strong natural feeling of reverence accumulates a store of ideas of things venerable, and gives them precedence in the resurrections of thought.

This peculiarity has often arrested attention, and has been adopted as a theme both by poets and by philosophers. An intellectual and cultivated nature strives to maintain the ascendancy of the intellectual associations over the suggestions of emotion. This is one of the forms of the dominion of reason in the mind.

When a particular emotion is excessive in the character, not only can we readily predict the actions, we can almost read the thoughts of the individual. The anecdote of Burke's divination of the thoughts of Goldsmith, when passing a crowd collected by the feats of a mountebank, can scarcely be called extravagant as an illustration of this point.

INFLUENCE OF VOLITION.

13. In many cases our recollection of the past is promoted by Volition; that is, we have some purpose or end in view which stimulates the activity of the system to bring about the recovery. I wish to recall the name of an object before me, to remember where I last saw a given person, to find a principle applicable to a case in hand. For a time, I fail in my endeavour, but, by prolonged effort, I at last effect the desired recovery.

It is interesting to ascertain, in what precise form the power of the will makes itself felt in aiding the intellectual forces of reproduction. At what point does this influence operate? Can it simply augment a contiguous adhesiveness too feeble, or the attraction of a similarity too little marked?

To the best of my judgment, the influence is indirect; that is to say, there is no power of increasing the energy of the associating bond either of contiguity or of similarity, by a voluntary effort. The reproductions of the intellect are withdrawn from the control of volition. I know no fact that would tend to show, that one thought can be made to succeed another, by mere will, as one movement of a limb may be made to succeed another. The modes of interference of a volition, I conceive to be as follows:

(1.) In exciting the nervous system, so as to exalt the intensity of the mental processes. It is the nature of an end strongly felt, to stimulate and excite the whole frame of body and mind. Difficulty adds fuel to the flame. In such a state of things, everything we do is done with more vigour. The bodily efforts are stronger, the senses are more alive, the volitions are more intense, the intellect is sharpened. Not that excitement always produces these effects unmixed. It occasionally happens, that the system is incapacitated for a pressing emergency, by the unusual fervour communicated to the bodily and mental movements. Some constitutions are rendered more alert and active by excitement, others are unhinged.

(2.) Volition may govern intellectual attention, in the same manner as observation is influenced by our will. When many things are before the eye, some are observed, and the rest passed by. A strong liking for one object of the scene stimulates the movements that direct the gaze in that direction ; as an infant turns its eyes to the flame of a candle or a familiar face. Now, I have already maintained a lengthened argument to show that, in the recovery of objects as ideas, when they are no longer present as realities, the same nervous circles and the same organs of sense and movement are occupied, as in the original perception during the actual presence. The ideal picture of a building is a series of impressions, sustained in the optic and moving apparatus of the eye, and in the circles of the brain that were effected, at the time when we were gazing on the actual building. Wherefore, as we have the power to prolong our gaze at pleasure upon the real object, to turn from one part to another, to examine some points minutely and pass the rest over, so when this building becomes a recollection, the same power of varying the inward gaze remains to us. We can dwell upon the outline, to the exclusion of the details, we can concentrate the attention upon a column or a cornice, we can indulge our recollection of the appearance of the material ; in a word, we can deal with the idea, notion, or recollection, as we could with the reality. Volition is not crippled by the transition from the actual to the ideal ; the reason is, as I conceive, that the same organs are concerned in both. If the objects of observation were made to pass into a separate chamber of the mind, when they existed as ideas, I should have a difficulty in comprehending how they could be reached by this voluntary control; because I look upon volition as existing only in connexion with the active organs, that is, with the muscular system. Even in the sphere of thought, this limitation holds; at least such is my view. The same volition that rules the bodily eye, can rule the mental, because that mental eye is still the bodily one.

Thus, then, volition operates in aiding the recovery of the past, through the power of directing and fixing the attention on any of the objects present to the mind at the time, to the exclusion of others. I remember one link of an otherwise forgotten chain: I dwell upon this link till it becomes more vivid itself, and thus acquire the power of calling up the rest. The object so selected is the one made vividly present, and thereby becomes the starting-point of association. The idea that next comes up in the movement of reproduction, will be some associate, or similar, of this; just as the thing that we select for special observation out of a various array seen by the eye, will be the thing that will suggest the next idea that rises before the mind. We can, therefore, always give a *preference of attention* to one of the many objects that come up to our recollection, and whichever is thus preferred, will be constituted the suggestive object; and, accordingly, it will happen that the resuscitated trains will be those in accordance with the purposes or ends of the moment.

In difficult or laboured recollection, we have already seen that the chief hope lies in attaining additional bonds of association. An effort of volition puts us in the way of commanding these. The effort consists in fastening the attention on various things within the view till these, one after another, are rendered suggestive of trains of ideas, some one of which perchance may have a connexion with the thing sought, and may supplement the deficient bond up to the full power of recall. In searching for a historic parallel, for example, we may suppose the power of similarity unequal to the task of invoking a proper instance. The mind then starts off in a train of contiguity over the field of history; which proceeds not by any voluntary power of commanding one fact to succeed another, but by directing the view on a starting point, the age of Alexander the Great, for instance; with the attention fixed on him, the associated particulars of his time, so far as they have been made coherent, flow in of their own accord. This power of concentrating the attention on any part of a circle of notions present to the mind, like the power of directing the observation on some one aspect of a real scene, is, in my view, the main function of volition in the restorations due to intellect.

THE SINGLING OUT OF ONE AMONG MANY TRAINS.

14. If I look at a mountain, there are many trains that I may be led into, by taking this as a point to start from. By contiguity, I may pass to the other mountains of the chain, to the valleys and villages beyond, to the mineral composition of the mass, to the botany, to the geological structure, to the historical events happening there. By similarity, I may be led away to mountains that I have seen in other lands, or in the representations of the painter and poet, to the analogous geometrical forms, to equivalent artistic effects. All these vents may be open to me, but it will happen that I go on some one track by preference, and there will be a reason for this preference. Perhaps one of the associations may have come by repetition to have greater force than any other; I may have been so accustomed to associate together the mountain and the neighbouring village, that I am led at once upon this one special transition. Another cause may be the presence of a second associating bond. If I see the adjoining mountain, I am then liable to be led along the chain; if I catch the glancings of the cascades, there is a double link of contiguity, tending to carry my mind to the river flowing from the sides of the mountain. If historical events have been recently in my mind, the events referable to this locality are suggested. If botany or geology is my study, a bent corresponding to these is impressed on the current of thought. If a geometer, the forms suggested to me by preference are the figures of geometry; if an artist, the forms of art spring up instead.

A case like this almost demands a compound attraction to make the mind move at all. We might imagine an intellectual situation so equally balanced, that no restoration took place in any direction, just as in a conflict of equal volitions. Some *inequality* of restorative power in the various trains, or some second association coming in aid of one to give that one a preponderance, is the condition of an effective recollection in any direction. The case of an intellectual stand-still between opposing suggestions is neither chimerical nor unexampled.

I will suppose another instance. A violent storm has flooded the rivers, blown down trees and buildings, and inspired general terror. The trains of thought suggested by such an incident are extremely various, and will depend on the mental condition of the observer in other respects, or on the special ideas that concur with the aspect common to all. The sailor's wife thinks of her husband at sea. The merchant and underwriter have their thoughts on the same element. The farmer calculates the losses to his fields. The mill-owner sees a prospect of abundant water power. The meteorologist studies the direction, duration, and force of the hurricane, and compares it with previous cases. The poet sees grand and imposing effects. The religious man has his mind carried upwards to the Deity.

These instances imply some *habitual attitude* of the mind, or an emotion, occupation, or pursuit, ever ready as a starting-point to the intellectual movement, and combining itself with every casual impetus given to the mental trains, so as to constitute an element of the composite effect. The principle is exactly the same in cases where the second association is present merely by accident.

15. We have more than once adverted to the mental aggregates, formed by the cluster of properties attaching to natural objects, especially as viewed by the scientific mind. Thus the idea of the mineral quartz is a vast assemblage of facts, properties, and influences, all which are liable to come before the view, when the mineral is seen or named. So even a naked circle is rich in associations to the geometrical mind.

It does not therefore follow that, every time a mineralogist looks upon a piece of quartz, all its many qualities shall rise and pass before his view, or that every circle shall hurry the mind of a geometer all through the Third Book of Euclid. The associating links in both cases are good and sound; but some motive additional to the force of the acquired adhesions is needed actually to recover the train. Not only must the mind be disengaged from other trains, there must also be a positive stimulus, a second starting point, to individualize and determine the bent of the suggesting power to one or other of the many associated ideas. If I am handling a piece of quartz and trying a knife edge upon it, the degree of hardness of the mineral is the quality suggested; if an acid is at hand, the chemical action of quartz is brought up to the view, and so on. When one of the many properties of the circle strung together in the mind of a mathematician is resuscitated by preference, it is by the agency of some specializing notion pointing to that individual. The most highly cultivated mind has moments of quiescence, and yet how numerous the possible outlets of thought at every moment!

OBSTRUCTIVE ASSOCIATIONS.

16. It will have occurred to the reader, that thoughts may be prevented from rising in the mind, notwithstanding an adequate force of association with something already present I have shown how a strong emotion will forbid objects discordant with it to make their appearance; and it has just been seen, that one object is brought forward and others kept in the background, in consequence solely of the excess of force in the favoured direction.

This is not all. A recollection is sometimes made impossible, through the mind's being inextricably seized with something very near what is sought, but yet different. We are often in this state of embarrassment in remembering names. Falling accidentally into a wrong articulation, we are unable to get free of the coil; and it is not till some time afterwards, that we are even in a position to give a fair trial to the recollective adhesion actually existing in the case. So, a stroke of similarity may be effectually resisted, by the presence of a second idea repugnant to the reinstatement. The principle of compound association necessarily implies this power of obstruction. If two ideas, by both pointing to a third, constitute a prevailing bond of restoration, it must likewise happen that if these two present ideas point in opposite directions, they will be liable to neutralize one another's efficacy. The power of assisting implies the power of resisting.

Both in the subject of the present chapter, and in speaking of constructive associations in the following chapter, we have room for exemplifying the distracting influence of too many ideas. Promptitude of action is exceedingly favoured by the fewness of the considerations that enter into a case. Marvels of ingenuity are often accomplished through the lucky absence of superfluous suggestions. In the operations of Animals, happy efforts occur to surprise us, as being apparently out of keeping with the range of their faculties; in some of those cases, the explanation is to be sought in the limitation of the views. The animal does not suffer from a crowd of incompatible associations. The same circumstance explains the extraordinary facility of speech, or the readiness in action, of men very deficient in mental force generally. It is observed by philologists that our cultivated languages have ceased to form new roots. The reason is, that the existing roots stand in the way. In things generally, originality is arrested by the presence of a large stock of already-formed conceptions. Children, before learning the common-places, often give birth to original remarks.

17. Obstructive association may be traced, on a grand scale, in the conflict of different modes of viewing the objects and occurrences of the world. There is a standing hostility between the Artistic and the Scientific modes of looking at things, and an opposition less marked between the Scientific, or the Theoretical, and the Practical points of view. The artistic mind is obstructed by the presence of considerations of scientific truth; and the scientific mind, bent on being

artistic, walks encumbered, and with diminished energy. Poetic fiction is never so brilliant as when the trammels of truth are set aside.

A good instance of the obstructiveness of incompatible ideas is found in the effort of guessing riddles and conundrums. These usually turn upon the equivocal meanings of words. Now a mind that makes use of language to pass to the serious import or genuine meanings, is disqualified from following out the play of equivocation, not because the requisite associations do not exist, but because these are overborne by others inimical to the whole proceeding.

ASSOCIATION OF CONTRAST.

18. Aristotle's enumeration of the associating principles of the mind included Contrariety, along with Similarity and Coadjacency.* Various subsequent writers have likewise viewed Contrast as a primitive suggesting force of our intellectual constitution.

It is a well-known fact that objects do, on many occasions, bring before the mind their contraries. An intense light will suggest darkness or shade; present sorrows will bring up past joys; and a moment of brilliant prosperity may not be unfavourable to the recollection of times of adversity.

Contrast is the reproductive phase of the first law of Mind, Relativity, or Discrimination. Everything known to us is known in connexion with something else, the opposite or negation of itself; light implies darkness; heat supposes cold. Knowledge, like consciousness, in the last resort, is a transition from one state to another, and both states are included in the act of knowing either. Nothing, then, can be more natural, when we are considering any one property, than the disposition to revert to the other property which makes its contrast, or opposite, the thing denied when it is affirmed. 'Great' would have no meaning to us, would never

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* See Sir W. Hamilton's *Contribution towards a History of the Doctrine of Mental Suggestion or Association.*—Reid, Note D. * *

have been named or marked as a quality, if we had not had before us things of unequal magnitude, whose difference or contrast affected our minds with a lively impression. The 'great' is great only because there is a something else 'not great,' or 'small'; even when we imagine we are looking at the single property greatness, we have in our minds by *implication* the alternative, smallness ; and it is only like reversing the magnet, to pass to the *explicit* consideration of that, in which case the other, 'greatness,' would be the implied property. This is what we do, when we pass from one member of a contrast to the other ; both members must be present, although we make either the explicit object of consideration for the time. That the other member is still present in a manner, is shown by the fact that, if we have been long absent from the express consideration of the alternative, we become oblivious to the force of the principal. The effect of summer warmth continued for a length of time, is to diminish the sense of warmth ; a few wintry days interpolated would revive the poignancy of the sensation. When a meaning is but dimly perceived by any one, the fault most frequently lies in the non-recognition of the opposite, or the thing to be excluded or denied, the supplying of which renders the notion luminous at once. Show a child a rod, and tell him that it is straight ; you will probably convey no notion whatever to his mind; but present at the same time a bent rod, and say that it is *not* straight, but bent, and you impart a genuine cognition. Thus, then, whenever we have an object on our view, we have by implication the opposite, and can on the smallest motive reverse the couple, which is to pass to the contrast. Thinking of 'just,' with some definite meaning, we must have in the mind, only in a less prominent shape, the notion of some things that would be the reverse of just; and if we want to make the idea of the just more lively and definite still, we pass for a time to the explicit consideration of those 'not just' things, and then return to the other. An artist knows that the contrast is the life of every effect, and knowing this he takes care to group accordingly. A scientific expounder knows likewise that to add the 'antithesis' or 'counter-proposition,' is only completing the statement according to the fundamental law of cognition; hence in him the 'association of contrast,' or the practice of passing from the thing affirmed to the thing denied, before quitting the subject of his exposition, is strong and confirmed.

19. But, farther, it is to be observed that the other powers of the Intellect, Retentiveness or Contiguity, and Similarity, concur with the primordial principle of Relation in enabling us to pass from one thing to its contrast. Thus, as regards Contiguity, it happens that the greater number of contrasts are, in consequence of their necessary proximity from the nature of knowledge, habitually coupled together in common speech, and we thereby acquire a tendency to pass from the one to the other by mere rote, like completing a hackneyed form of words. Such associated couples as white and black, high and low, up and down, large and small, thick and thin, weak and strong, young and old, rich and poor, life and death, pain and pleasure, true and false,—are in everybody's memory; if one member is presented, the other is instantly ready to come up. Among our acquisitions of Contiguity, a great number of these contrasting pairs are to be found. This fact alone would suffice to render contrasting qualities frequently suggestive of each other.

Next, as to Similarity. It is an old maxim, that contraries imply community of kind. Where there is nothing common, there can be no opposition. We oppose a long road to a short road, we cannot oppose a long road to a loud sound. We can contrast black with white, because they agree in kind—they are both colours and modes of light. Thus it is, that, when any quality is present to the mind, the opposite quality never can be far off, seeing that this is only another species of the same kind of object. When we see any one gaily attired, the subject of personal decoration is brought before the view, and one variety of it suggests other varieties by virtue of the generic agreement, and, among these suggested instances there may occur cases of squalor or meanness. So when we encounter a person of low fortunes, the subject of human conditions is present to the view, and by Similarity other instances may be brought up, the first to occur being naturally those agreeing in the features of the present case, but not to the exclusion of cases with varying or even contrasting features. One member of a class may at any time suggest the remaining members, notwithstanding the differences that coexist with what is common to the whole class. This is a case of the law of similarity.

We have further to note the *emotion* that contrasts give rise to, tending to impress them on the mind with more than ordinary force. This does not happen in all contrasts, but there are some peculiarly disposed to generate strong feeling.

To take one class of examples. When any quality is present in a painful excess, the opposite quality is unavoidably suggested as a remedy to the evil. Darkness in this way causes a craving for light, and too much light impels us to seek the shade. So, cold and heat, hunger and repletion, exercise and rest, and many other things operate in the same way.

20. Again, there is a strong emotion of the poetic or artistic kind, generated by many contrasts. We are moved by seeing infancy and age placed together; the still greater contrast of life and death has a solemnizing influence. In the fortunes of men and nations, we are struck with the conjunction of the high and the low, with the greatness that has emerged from obscurity, and the pride that goeth before a fall. This effect has been worked up in the poetic literature of nations. Among the Greeks, the idea of the *nemesis* was an intense ever-present conception; even the accurate mind of Herodotus was superstitiously sensitive on this point. In no age has either the poet, or the moralist, allowed the reverses of human conditions to drop out of the view of the multitude. All the contrasts of this class are therefore disposed to be mutually suggestive to a very high degree.

Another striking example of the influence of emotion in determining the rise of thoughts, is furnished by the well-known feeling called the love of contradiction. The clear expositor of truth knows that contrast is a means of illustration, and is moved in that ground to pass from a different idea or proposition to the opposite; while the contentious disposition produces the same tendency to search out the contradictory of every affirmation that happens to be brought forward.

21. A better use of the reproductive power of contrast, is to guide us to unity and consistency in our opinions or beliefs. If we hear anything stated at variance with something previously known or believed, we are likely to be reminded of the former statement. If I have ever affirmed or admitted the allegation, that the Homeric poems were the work of one man, and if now I am asked to believe that these poems were composed by several authors, I cannot help being reminded of my former belief, seeing that the subject, namely, 'the authorship of the Homeric poems' carries me back to former occasions when the same subject was under my consideration, and makes present the opinion then entertained on the subject. In this way, the past and the present are confronted as effectually as if the opposites had been affirmed at the same moment, and I am thereupon urged, by the whole force of revulsion against inconsistency, inherent in my nature, to dismiss one or other of the conflicting opinions.

The power of Similarity, under the guise of Contrast, is thus able to rid the mind of contradictions, in so far as this can be done by bringing the conflicting opinions face to face. A present assertion revives any past assertion that may have been made on the same subject, and, if the two are contradictory, there is opportunity given for choosing between the two. It happens, however, in fact, that the same mind will at different times maintain irreconcilable propositions unawares. Either the power of reinstatement by similarity is too feeble, or there is some strong feeling at work that repels the approach of any fact not in accordance with the view held for the time being. Both causes are found at work. In an average intellect, the power of similarity is not energetic enough to search the past for all the statements that may have been made upon any subject now in hand. Many inconsistencies are too subtle for the detection of an ordinary mind. When we add the power of emotion,—the influence of the likings and dislikings,—to this intellectual feebleness, we have a sufficient explanation of the co-existence of contradictions in the same mind. It has been already observed, that a strong feeling will rebut all ideas incompatible with itself, however strongly they may be suggested by the forces of association. I can suppose the Apostle Peter to have been unconscious of contradicting himself within a few hours, when under excitement for his personal safety. The strong affirmations he had so lately made on the very same subject might not even have come into his mind. A current of violent emotion, besides overbearing hostile considerations that may be actually before the mind, can so obstruct, I might almost say paralyze, the workings of association, that such considerations, however near, shall not be allowed to come on the stage. This is one of the characteristic influences of emotion. Intellect cannot perform its ordinary functions in the presence of strong feeling. The accordance or discordance of objects and recollected ideas with the present emotion, counts for so much in the recovery of the past, that the purely intellectual links may have but a small share in the result. The tendency of intellect proper is to banish all contradictions from the mind; in other words, to arrive at consistency, the test of truth: the tendency of men's emotions of all kinds runs counter to this, and renders the spectacle of a thoroughly consistent human being no less rare than admirable.

CHAPTER IV.

CONSTRUCTIVE ASSOCIATION.

By means of association, the mind has the power to form combinations, or aggregates, different from any that have been presented to it in the course of experience.

1. THROUGHOUT the whole of the preceding exposition, we have had in view the literal resuscitation, revival, or reinstatement of former sensations, images, emotions, and trains of thought. No special reference has been made to the operations known by such names as Imagination, Creation, Constructiveness, Origination; through which we are supposed to put together new forms, or to construct images, conceptions, pictures, and modes of working, such as we have never before had any experience of. Yet the genius of the Painter, the Poet, the Musician, and the Inventor in the arts and sciences, evidently implies such a process as this.

Under the head of Similarity, we have had to recognize a power tending to originality and invention, as when, in virtue of the identifying of two things formerly considered remote from each other, whatever is known of the one is instantly transferred to the other, thereby constituting a new and instructive combination of ideas. Such was the case when Franklin's identification of electricity and thunder, led to the application of the Leyden jar to explain a thunder-storm. The power of recalling like by like, in spite of remoteness, disguise, and false lures, enters, as we have seen, into a very large number of inventive efforts, both in the sciences and in the arts. But we have now to consider constructions of a higher order of complexity. There are discoveries that seem nothing short of absolute creations, as for example, the whole science of Mathematics; while in the Fine Arts, a Gothic cathedral, a frieze of the Parthenon, a Paradise Lost, are very far from repetitions of experienced objects, even with all the power of extension that the highest reach of the identifying faculty can impart.

Nevertheless, I mean to affirm that the intellectual forces operating in those creations, are no other than the associating forces already discussed. The new combinations grow out of elements that are already in the possession of the mind, and that are brought up to the view according to the laws above laid down. This position I shall now endeavour to illustrate.

MECHANICAL CONSTRUCTIVENESS.

2. In our mechanical education, complex and difficult actions are acquired by taking the simple acts separately. We learn part No. 1 by itself; then part No. 2, No. 3, and so on; and if each of these parts be so firmly acquired, as to be maintained without any exercise of the attention, there will be no new labour in performing them altogether. The performance of the whole is the performance of the parts; a *volition* directing the order and time of the various exertions, constitutes all that can be pointed out as peculiar to the fact of combination.

Most commonly mechanical combinations are learned, by keeping up the exercise of the parts already acquired, and adding new ones in the manner now indicated. Thus, in learning to dance, the pupil is first put through the simple positions and steps; and when these are firmly fixed, they are performed with additions, and so on, until an exceedingly complex movement is arrived at. There is no new fact of mind, in passing from the performance of a single act by itself, to the performance of that act in company with a second; the only peculiarity of the case is the demand for the thorough acquisition of the one movement, before the attention is directed upon some other movement. When the degree of cohesion is sufficient to make the first of the two self-supporting, there is nothing else wanted to make it combine with the second.

Our mechanical acquirements often demand the *suppression* of one member of a complex action, a decomposition, as it were, of some of the concurring movements that we have seen to be natural to the system. In this case, a voluntary effort is directed upon the member whose movement is to be suppressed. In walking, there is a natural tendency to swing the arms and the body along with the lower limbs. By a voluntary effort, these extra movements may be arrested, and the primitive aggregate reduced to a smaller aggregate.

Learning to swim is a good example of the peculiarities of the constructive operation. The will has acquired the command of the arms, and of the lower extremities, separately yet not in the proper rhythm, or combination. We can will movements in both sets of members to happen together, but it is only by a lucky accident, after numerous attempts, that these movements fall into the right union. When the coincidence takes place at last, we maintain it by that primordial power of our constitution, from which our voluntary acquisitions take their start—the continuing of a movement once hit upon, if it causes pleasure, or alleviates pain. Nothing comes more decidedly under this last condition, than a successful effort, after many vain struggles.

VERBAL CONSTRUCTIVENESS.

3. The facility in passing from mere repetition into new combinations, is perhaps most obvious in the use of language. Scarcely any succession of words, uttered in everyday intercourse, is precisely the same as any other succession formerly said or heard by the speaker. It seems particularly easy for us to adapt and modify this acquisition to our purposes.

In the early efforts of imitation, whereby words are first learned, there is a constructive process. The child has learned to say *ba* and *na*, and when these separate sounds become very easy to the organs, a chance impulse makes them run together into *ban*. Here, as before, the ripeness of the preliminary acquirements separately, is the main condition.

When a number of words have been acquired, with a few simple forms of intelligible sentences, it becomes easy to make new applications of these forms. The child has learned to say 'give me,' and also the names of a number of other persons and things, 'mamma,' 'pussy,' 'dolly;' and having the wish to give something to one of these other parties, there is no difficulty in displacing 'me' from the formula, and admitting 'mamma,' 'pussy,' as the case may be. An effort of volition is implied. Two utterances are present to the mind; the articulate activity is awakened and repeats these utterances perhaps in two or three ways; one is hit upon, such as to satisfy the purpose of the moment, and, being hit upon, is retained and repeated. The effort of substitution, once or twice put in practice, becomes easy; the mind knows as it were to carry on the current of words so far, then to stop, and to fall into a different current, so as thereby to produce a third, different from either. It is a part of the voluntary command that we acquire over our actions, that we can stop a train at any stage, and commence another train from that point, and this is all that is required in such a case of verbal substitution as we have now supposed. Out of the two sentences, 'I am going out for the day,' 'I am coming home for the night,' a third sentence is constructed, 'I am going out for the night,' by no further effort of volition than this, namely, to arrest the current of articulation at a certain point in the first, to pass into the second, suspending vocal articulation till the word 'for' is reached, then to tack on the remainder to the words already enounced from the other. The constructiveness, therefore, lies not in any purely intellectual operation, but in the command that the volition has obtained over the movements, by virtue of which command, these are suspended and commenced at pleasure, in the service of a particular end. The intellectual forces bring to mind the former acquisitions bearing on the situation, and if no one previous form is strictly applicable, it is a property of the volition to take part of one and part of another, and to make successive trials, if necessary, until the want is satisfied.

Throughout the whole wide-ranging operation of adapting old forms of words to new meanings, this is essentially the process pursued. When all the elements requisite for a new combination, are at hand, a volition alone is needed to make the selection and adaptation suited to the end in view. When there is not a sufficiency of forms within reach of the present recollection, the processes of intellectual recovery must be plied to bring up others, until the desired combination is attained. A voluntary effort is quite equal to the task of cutting down and making up, choosing and rejecting, sorting and re-sorting; *the feeling of the end to be served*, is the criterion to judge by, and when this is satisfied, the volition ceases, the stimulus being no longer present. In all difficult operations for purposes or ends, the rule of trial and error is the grand and final resort.

It would thus appear, that the first condition of good verbal combinations for the expression of meaning, is a sufficient abundance of already formed combinations to choose from; in other words, the effect depends on the previous acquisitions, and on the associating forces whereby old forms are revived for the new occasion. If a complex meaning has to be expressed, every part of this meaning will revive, by contiguity and similarity, some former idea of an identical or like nature, and the language therewith associated; and out of the mixed assemblage of foregone phrases, the volition must combine a whole into the requisite unity, by trial and error. The more abundant and choice the material supplied from the past by the forces of intellectual recovery, the better will be the combination that it is possible for the mind to form by the selecting effort.

4. Let us next advert to some of the other conditions that have to be satisfied in making verbal combinations; for as yet I have alluded only to the one condition of conveying a given meaning. Certain grammatical forms have to be observed; likewise, there are rhetorical properties or rules of

good taste ; a certain melody or cadence is sought to be imparted ; and, in poetic composition, this last quality has to be attained under the restrictions of metre and rhyme. As a matter of course, the more numerous the conditions, the more difficult it is to satisfy them all ; but the mode of proceeding is not altered in any essential point. When there are four or five different conditions to satisfy, the range of choice must be so much the wider. It is not enough, that I can combine one form of words sufficient to express a certain meaning ; I must be able from my verbal resources, recovered from the past, to construct several forms all equally good as regards meaning, so that I may be able to choose the one that satisfies the other conditions as well. In fact, the mind must possess not one way of bringing out a certain effect, but a plurality of ways, and, out of this plurality, we fix upon the form that yields some second effect also desired. If a third effect is wanted, there must be a power of altering the combination already made, without losing those already gained ; and for this end, we must be able to command a choice of equivalent phrases, in the room of those that are discordant as regards the new end.* Thus it is that we must have a plurality of ways of expressing any given meaning, a plurality of forms of the same grammatical construction, a plurality of forms of the same rhetorical propriety, and a great variety of sequences observing the same cadence. Out of this opulence of synonymes, we, at last, light upon a combination that satisfies all the conditions of the case. The refusal to combine in any case can only be met by bringing forward new varieties of phrase, sometimes by the bond of meaning, at other times by the bond of grammar, of taste, or cadence. The more richly stored the mind is on any one of those particulars, that is, the

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* Southey's lines on the Fall of Lodore are an instance to show that a word-artist is a person that can bring up for any occasion a large variety of names for the same thing. It is by means of this abundance of past and recoverable phraseology, that the elaborate constructions of high composition are at all possible. The number of words that pass across the mind in forming a single couplet, may be a hundred times those actually made use of.

greater the number of words associated with meanings, or with melodious falls, the more surely will that one condition be observed, whatever may become of the rest. If the tendency of the mind has been to lay up stores of expressions adapted to the conveyance of meaning, there will be no difficulty in matching a new meaning, although there may be a difficulty in getting the language to comply with other requisites. If, on the other hand, through a great susceptibility to cadence, and by being very much versed in melodious forms of speech, these forms be ready to occur in great abundance on all occasions, the flow of speech will be sure to be musical, but there will be no security for the compliance with the other conditions ; and it may happen that both sense and grammar are neglected. Still out of the abundance of choice presented by this acquisition, a patient mind may seize upon forms that shall not be devoid of any of the other important attributes. Or, if the first suggestion of the material of a sentence is left to associations with meaning, it will be easy for such a mind to make substitutions and alterations to meet the oratorical condition. In these efforts of combination, the disposition of the mind to be satisfied with a more or less perfect reconciliation of the conflicting claims, is always an element in the result.

FEELINGS OF MOVEMENT.

5. We next proceed to exemplify constructiveness among our feelings and ideas.

Movement gives rise, as has been seen, to a variety of conscious states ; some emotional, as the states of exercise and repose, and others with an almost exclusively intellectual character, as the feelings of pressure, space, and form. I shall here take a few examples from the last class.

Having acquired a discriminative sensibility corresponding to some one resistance or pressure, it is possible for us to construct the feeling of another differing in degree. I possess in my hand, after much practice, the engrained impression, say, of a pound weight; and I am commanded to construct, conceive, or imagine, the impression corresponding to two pounds. For this end, I must endeavour to fuse the two notions of one pound and of a double, being formerly very familiar with both in their separation; the notion of doubleness being derived from my experience of the fact in quantities of various kinds. By keeping my mind very much bent upon the two elements in question, I may succeed in conjuring up an impression compounded of both, and very nearly corresponding to the actual feeling of a two-pound weight in my hand. If there be any difficulty in the case, this will arise from my not being perfectly in possession of the separate notions, more especially the feeling of the one pound. In the same way I might attain a conception of half a pound, of three pounds, and less accurately of ten or twenty pounds. The more delicate my perception of the degrees of the quality, as felt by my muscular sensibility, the nearer I should come to the mark, for it is possible to increase or diminish a perception of this kind, and if we have a sufficiently nice judgment of the result, when actually attained, we shall succeed in the construction aimed at.

We are not unfrequently called upon to make efforts implying this sort of adaptiveness. If I have been accustomed to jump a ditch three feet wide, I can easily increase the notion of the effort requisite for five feet. So in throwing objects to hit a mark; we have, in this case, a power of graduating our strength, by combining our notion of increased or diminished quantity with the acquired sensibility corresponding to some one distance. In this case, the constructiveness is first operated upon the pre-conceived *idea* of the action, whence it passes to the action itself.

The same power of changing degree may be put forth in reference to size and form. Having acquired the arm-sensibility to a sweep of one foot, we can construct a feeling corresponding to the sweep of two feet, or half a foot. We can also change a given area from one form to another. By fixing the mind upon the form of a circle, and the area of a pane of glass, we can construct the conception of a round piece of the same extent.

The emotional feelings of movement present a somewhat different case. Under the two next heads, I shall adduce examples of emotional constructiveness generally.

CONSTRUCTIVENESS IN THE SENSATIONS.

6. Beginning with organic sensibility, we might cite instances of constructiveness, in the endeavour to conceive pains or hurts of a kind different from any we have experienced. We can, as usual, make the change of degree; and if the new state is a combination of two already familiar to us, or one minus some second, the conception is more or less in our power.

The agreeable and joyous states of general sensibility are very various. Each one has experience of some of them: and, starting from these, we may be made to conceive others, if the description, that is, the method of compounding the known into the known, be clearly given. I may never have experienced the ecstasy of intoxication by opium, but if I have felt a number of states whose combination would amount to this effect, and if these are pointed out to me, I can, by an effort, recall and fuse them into one whole, so as to construct the feeling in question. This is by no means an easy undertaking to the generality of people; and the reason is, that the strong organic feelings are not readily recoverable at all times in their entire fulness. Some one leading element of the combination sought would require to be present in the reality, and then it might be possible to bring up others, and to form a new conception, by introducing the requisite modifications. But, on the other hand, this method has its disadvantages; it is not easy to modify a strong and present reality by mere ideas; it would be more practicable to modify a mere recollection, which is itself an ideal thing. The non-intellectual nature of the organic feelings, rendering them stubborn to recall, however powerful they be in the reality, is the great obstacle to our easily conceiving inexperienced varieties of them. A person may have enjoyed the pleasures of eating, in a sufficient number of forms to possess all the elements necessary for conceiving the most luxurious feast that ever mortal man sat down to, yet it may not be possible to attain to the conception. The difficulty of forming new combinations, in some one region of sensations, is only another proof of the difficulty of retaining and recovering our own experiences in that region. If I cannot easily conceive a degree, or kind of hunger, beyond anything I have ever known, it is because the states of hunger that I have actually experienced, cannot be well restored after they have completely passed away.

Tastes, properly so called, being somewhat more intellectual than organic states, we can do more in the way of forming new combinations of them. Given a bitter, such as bitter aloes, and a saline taste, as of common salt, one might construct a taste combined of the two. So a sweet and an astringent might be fused. We might thus attain to the conception of tastes not actually experienced. The effort would doubtless be laborious in most instances, owing to the imperfect recollection that we have of tastes, even after much repetition. A person specially educated in tasting would have so much less difficulty. If we wished to retain and revive the new conception, and to make it a possession of the mind, as much as the taste of sugar, we should require to repeat the effort of fusion a great many times.

7. Without dwelling upon the almost parallel case of smells, I shall pass to the first of the intellectual senses. Touch, including the muscular feelings associated with the proper tactile sensibility, furnishes a more abiding species of recollections than the sensations just noticed, and we may therefore look for a higher degree of combining power among the feelings characteristic of this sense. I can acquire the touch of an orange, that is, the bulk, the weight, and the character of the surface. I have acquired also the touch of a marble table, and the weight of marble as compared with other substances. By a voluntary exertion of the mind,

directing the view on the round figure of the orange, and on the touch and specific gravity of the marble, I can make to emerge a new conception, the collective impression of a marble ball equal in size to the orange. Part of the difficulty, in this trial, consists in the disassociating or separating of elements that have grown together in the mind; this exercise is commonly spoken of as an effort of abstraction, or *analysis*, and is arduous, on the one hand, according to the hold that the property to be disassociated has taken of the mind, and, on the other hand, according to the little hold that we have of the property to be substituted. If I were very strongly affected by the peculiar soft touch of the orange, and had very little interest in the cold hard contact of the marble, there would be a repugnance in my mind to the proposed transmutation, and the effort of abstractive, or analytic, volition, preparatory to the new combination, would be very severe. A mind sensitive to the warm and sensuous elements of touch and colour, revolts from the operation, so familiar to the mathematician, of stripping these off, and leaving only naked forms and arbitrary symbols to engage the intellect. The double decompositions illustrated by the above example, are made laborious, by every circumstance that favours in the mind a preference for the combinations already existing, and correspondingly easy, when there is a partiality for the new combination that is to be the result. Thus it is that even when we have got into subjects very conceivable and retainable, unlike the organic sensations lately noticed, other difficulties may arise to clog the constructive operation. The mere effort of analysis is itself something considerable, so much so, that this is not a favourite avocation of the untutored mind, with which associative growth is more genial than disassociating surgery; but when the analysis has to be applied to break up favourite combinations, and constitute others of an unattractive kind, we are then aware of the tyrannical influence that the likings and dislikings, the sympathies and antipathies, exert over the intellectual processes.

The very great difference between the constructions of

Imagination, and the combining operations for a Rational end, is herein faintly shadowed forth.

In the definition, or description, of the tactile quality of surfaces,—woods, cloths, minerals, metals,—reference must be made to touches familiar to us, by whose combination we are supposed to make up the feeling of a surface not experienced. Touch is one of the defining properties of minerals.

8. In the very various states of mind excited through the sense of Hearing, there is great room for new combinations and constructions, the mode of operating being much the same as in the preceding instances. We may hear a note, or an air, sounded by an instrument or voice, and may wish to imagine it on a different instrument or voice. If we have a good mental grasp of the air, and of the tones of the second instrument, this transference may be effected after a certain amount of effort. We have heard a piece performed on a fine band; and we desire to conceive the effect of some other piece performed on the same band. Some faint notion of the result of such a combination might be attained, but the exercise is not one that is much attempted. Few people engage in an occupation of this nature, or endeavour to create to themselves unexperienced impressions with an approach to the vividness of reality.

'Imagine Macready, or Rachel, delivering that passage.' We have heard the passage, and we have heard Macready. A constructive effort, taking place upon firm recollections of the two things to be combined, might be successful in such an instance. A good imitator, or mimic, actually succeeds in modifying his recollections of his original to suit an entirely new discourse. The ability to make the combination, as in all other cases, rests in the first instance on the vivid possession of the separate elements.

9. Under Sight, the sense of easy conception by preeminence, the examples of constructiveness are extremely copious. Light and shade, colour, lustre, size or dimensions, shape, distance, position,—are the constituents that concur in the complex perceptions of sight; and it is possible to vary

any given combination, by putting out and taking in elements at pleasure. I see or remember a line of houses; I can imagine it prolonged to double or triple the length; or I can transform the whole line by the addition of a story to the height. In the landscape I see a mountain and a wood standing apart; I place the wood upon the mountain. Or to take Hobbes's example of constructiveness :* I have the idea of a mountain and the idea of gold, and by superimposing the one upon the other, I can evoke the image of a mountain of gold. The facility in all such cases, depends, as usual, on the perfect and easy command the mind has of the separate ideas, owing to their having acquired a good ideal persistence. The combination takes place of its own accord, if the elements are once properly brought together and kept, as it were, in close contact for a sufficient time. A continuance of the effort will enable us to retain the new image, until the parts of it acquire a certain contiguous adhesiveness, after which we shall possess it as a mental recollection not differing essentially from the recollections of things actually seen. As in former examples, the decomposition and recomposition, implied in the constructive effort, may be aided or retarded by emotions. Hobbes's mountain of gold would emerge the more readily that the image is one to excite men's feelings, being an example of imagination in the more limited sense of the word, or in that sense wherein lies the contrast between it and the creations of the intellect for scientific or practical ends. If I see a dress, and want to conceive it of some other

* 'As when the *water*, or any liquid thing moved at once by *divers* movements, receiveth *one* motion compounded of them all; so also the brain, or spirit therein, having been stirred by *divers* objects, composeth an imagination of *divers* conceptions that appeareth single to the sense. As for example, the sense showeth at one time the figure of a *mountain*, and at another time the colour of *gold;* but the imagination afterwards hath them both at once in a *golden mountain.* From the same cause it is, there appear unto us *castles* in the *air*, *chimeras*, and other monsters which are *not* in *rerum naturâ*, but have been conceived by the sense in pieces at several times. And this composition is that which we commonly call *fiction* of the mind.'—*Discourse on Human Nature*, chap. iii., § 4.

colour, I can most easily substitute the colour that I am most familiar with, or one that I have a special affection for.

The redisposition of the parts of a complicated object is rather trying to the constructive faculty. Wishing to re-arrange the furniture of a room, I endeavour to conceive beforehand the effect of a proposed arrangement. So with a garden; a person must have a good retentiveness of the ideas of the parts, in order to put together, and hold firmly, the new plan, so as to judge of the effect of it before taking any measures to realize it. There is a great economy in the possession of such a power. A mind naturally pictorial, or disposed to retain visual images in general, and an education in the particular subject operated upon, are requisite for success in such an operation. The susceptibility to beauty, or to the emotional effects of the several combinations, acts in favour of every construction that yields the emotion, rendering it possible to put together those and separate others with far less difficulty.

CONSTRUCTION OF NEW EMOTIONS.

10. We may revive emotional states by contiguity or by similarity, or by a composition of associating bonds; and, from two or more states thus revived, new emotions may be generated by the working of the principle now under discussion. I have already touched upon this, in speaking of the organic sensations, these being almost purely emotional in their character. But if we pass to the feelings that are more recoverable and more retainable in the ideal form, we shall be in a better position for elucidating the peculiar features of the case.

The problem is to realize emotions such as we have never experienced in ourselves, or have experienced too rarely to recall them by any effort of mere recollection. The feelings belonging to men whose character, position, occupation, &c., are totally different from our own, can in general be conceived only through a constructive process, operating upon feelings that we do possess.

There are certain elementary emotions that belong to human nature in general, although manifested very unequally in consequence both of primitive differences of character, and of variety in the outward circumstances of individuals. Every one has experience of wonder, of fear, of love, of power, of anger, of vanity, of remorse. Should any one of the elementary feelings be absent from a character, no constructive process, is sufficient to create it; what constructiveness can produce is by that very fact not elementary. If, for example, a person were naturally devoid of the emotion of fear, this emotion could not be generated by any effort of composition that I am acquainted with. In like manner, the irascible feeling seems so distinct and peculiar that we could not be made to conceive it without direct experience. When any emotion not entirely wanting is yet allowed to sleep in the character, the difficulty of rousing it may prove insuperable; thus it is, that some men are unable to enter into the sentiment of religious veneration, and others are unable to comprehend the pleasures of the fine arts; one class are utterly incapable of sympathizing with the pursuit of scientific truth, and another can never be made to understand the feeling of disinterested usefulness.

The emotions that can be acquired by constructiveness are, therefore, the compound emotions, or some conceivable varieties of the elementary. We must be able in each case to specify certain primary feelings possessed by the person whom we address, the combination of which in a particular way shall yield the emotion that we desire to communicate or evoke. If the constituent elements are actually made present to the mind in their proper degree, the fusion will take place as a matter of course. Perhaps the best commencing exercise in this art of conceiving other men's feelings, would be to change the degree of one of our own emotions. I have a certain disposition to take on fear. It being, however, apparent that another person, whose character I am desirous of realizing, is susceptible to a much greater extent, I must endeavour to assume for a time a pitch of terror much beyond my own. This can be done in various ways. I may go back upon times of my life when the emotion took a greater hold of me; I may conceive occasions and circumstances of a kind to produce a more than ordinary degree of the state; or I may revert to the particular subject that most easily depresses my courage. Or, instead of working upon the emotion itself, I may exert my imagination to construct objects of intense and overpowering terror, from whose contemplation a high pitch of the feeling would arise. By these means, I can be made to assume an unwonted amount of the feeling, and can approach to the state of mind of the person supposed, so as to comprehend the actions flowing from that particular state.

By such efforts, one might acquire an exalted cast of any familiar emotion. The exercise would cost both effort and time, but if we are able to revive with ease the past states of our own experience that bear on the case, we shall not be long in accomplishing the end in view. To acquire a new degree of intensity of any emotion so thoroughly, as to be able to follow out all the influences and consequences of the feeling, is a very high effort and demands iteration and time; inasmuch as there is implied in it the process of fixing, into a permanent possession, a state of mind that has been worked up with labour. Thus, for the man that is only alive in a moderate degree to the pleasure of music, to be able, at any time, to rise to the state of an enthusiast, so as to depict that character in all its phases, there would be required a somewhat laborious training. Writers whose province it is to trace out and depict all the windings of characters different from their own, must work themselves into a number of unexperienced degrees and modes of feeling, as a preparation for their task.

11. The exercise of combining two emotions, so as to bring out a third different from either, is not intrinsically arduous. Everything depends, upon the facility of assuming the elementary feelings. Supposing a person inexperienced in the sentiment of property in land, but perfectly able to recall the feeling of property in other things and to conceive the emotions connected with land in men's minds generally, a fusion

of the two states would make some approximation to the proprietorial feeling. If a person has ever known an affection of the nature of a passion for any one object, such a one is capable of conceiving, by an effort of transference, a passion for an object very different. Thus it is that Michelet in endeavouring to pourtray the attachment of the French peasant proprietor for his land, brings into the picture the feelings of strong personal attachment. The difference of subject is great, but the attempt is not therefore hopeless. It would doubtless be much easier to transfer the feelings of love, in one personal relation, to some other relation, by making allowance for the difference, than to pass from friendship to marriage, or to the parental relation.

The historian, who has to deal with extinct modes of feeling, and who has to study truth in his delineations, is necessarily much versed in the exercise now under discussion. Mr. Grote forewarns his reader 'that there will occur numerous circumstances in the after political life of the Greeks which he will not comprehend unless he be initiated into the course of their legendary associations. He will not understand the frantic terror of the Athenian public during the Peloponnesian war, on the occasion of the mutilation of the statues called Hermæ, unless he enters into the way in which they connected their stability and security with the domiciliation of the gods in the soil.'—*Hist. of Greece*, Preface, p. 17.

CONCRETING THE ABSTRACT.

12. Under a former head, I have supposed the case of fusing the properties of two different objects so as to make a third different from either. Given a brick city and a marble surface, to conceive a marble city. This is to form a new concrete out of two pre-existing concretes. But we may go a step farther. Given the abstract properties, to construct the concrete whole. Take, for example, the geometrical form of a pyramid and the colour of granite, and conceive the actual object as existing in nature. This is, in most cases, a somewhat more difficult operation than the foregoing, but can

hardly be said to involve any new or distinct effort. If we realize the constituent elements with sufficient vigour, and keep the two together in the mind, the construction is sure to follow. If we have but a feeble hold of one or other of the parts, a certain effort will be requisite to make them fall into their places in the new compound.

When a plan and sections of a building are given, we have the means of realizing the form of the solid building; when we add the colour of the surface, or the appearance of the material to the eye, the concrete emerges in all its fulness. In this case, the plan and sections would not be enough to give the solid conception, unless we had previously seen solid shapes. We require to fasten upon some remembered building or form of building, and to alter this in the mind, till we bring out a correspondence between it and the plan supposed. Thus, in order to realize a gothic church from a builder's designs, the easiest way would be to direct the view upon some church already familiar to us, and on that to make the alteration prescribed by those designs. This is a general maxim in concrete realization, and by it we can easily understand the conditions that render the operation easy. It is evident that a previous store of well fixed objects of the particular kind in question, is the great requisite. If the past experience of the individual has given great opportunities for laying in such a store, and if the mind is naturally of a pictorial and concrete order, the process of new construction has every advantage in its favour. Not to speak of the chance of possessing firm and recoverable ideas of objects approaching very near the new construction, there is a great facility in making the required alterations, if the thing operated on is vividly and easily held in the view; provided always, that there is no serious obstruction from the feelings.

To imagine a country from a map is a case of the same nature. The effort consists in holding before the mind's eye a series of scenic views, in all the richness of the colouring, and all the fulness of the details, while performing the operation of cutting out and taking in, so as to suit the prescribed outlines. An intellect rich in concrete, or living, conceptions of actual nature possesses the prime requisite for such a task.

The mode of describing the objects of natural history is to enumerate the abstract properties. Thus a mineral is described by such abstractions as crystalline form, hardness, nature of surface, colour, lustre, &c. Now, by a vigorous effort of constructive conception, one might realize an actual specimen from the assemblage of abstract qualities. So with a plant or animal. The condition of success in this attempt is exactly the same as in the preceding examples. The mind must be well versed in actual specimens, so as to be able to lay hold of some concrete recollection, by operating upon which, a new specimen will emerge possessing all the properties of the description. A botanist can readily form to himself the picture of a new plant from the botanical description; a person less familiar with plants would find the construction very laborious, perhaps impossible.

13. The more we analyze or decompose concrete objects into the abstract qualities that make them up, the more difficult is it to remount to the concrete. Hence the most arduous attempt of all is to make actual nature rise up out of scientific and technical language,—to conceive minerals from a book of mineralogy, and the parts of the human body from anatomical description. This is the repulsive or unfavourable side of science and of abstract reasoning. On the other hand, it is by this process of resolving natural aggregates into their ultimate abstractions, that we obtain the means of making new constructions widely differing from, and superior to anything that exists in our experience, by which many important ends in human life are furthered. New creations of science, and new devices of industry, result from this power of reconstituting the ultimate abstract elements of existing things. Even the artist will find his account in it, although it is not usual with him to carry abstraction so far as the man of science, or the man of practice. Many great poetic conceptions are the embodiment of an abstract idea. Milton's personification of the spirit of evil may be quoted as an example.

REALIZING OF REPRESENTATION OR DESCRIPTION.

14. What we have to state on this head is little else than an application of the remarks already made. When we are desired to conceive an object differing from any that we have ever known, we can do so only by constructing it out of qualities and particulars indicated in a representation or description. The machinery of representation for such an end is known to be very various; including pictures, sculptures, models, diagrams, and, greatest of all, language. If we wish to conceive a living human face by means of a coloured portrait, we require an act of constructiveness to make up the difference between the painting and the reality; we must fuse or combine a living face with the features of the portrait, till the one is completely adapted to the other. The difficulty lies in separating the suggestive part of the picture from the gross total of canvas and colour, and the labour is greater according as the painter has attempted to produce a work of art, that is, a pleasing combination of colour and forms. There is here that effort of analysis, which I have already alluded to, as the preliminary of many constructions, rendering them often very hard to accomplish. The same remarks apply to sculpture. An unartistic model is the best medium for enabling the mind to rise to the living and actual reality.

15. Verbal description is the most universal mode of imparting to the mind new ideas and combinations; and the hearer or reader is called upon to put forth an effort of constructiveness to realize the intended image. There is only one method of procedure open to the party giving the description—to compose the unknown out of the known,—and the hearer must implement the process, by the force of his own mind bringing together the suggested particulars into a combined total, with the requisite inclusions and exclusions. Language is made the medium for indicating the things that are to be brought together, in the formation of the new compound.

16. With regard to the describing art in general, as appli-

cable to all cases where a complex object or scene has to be represented to the view, the leading maxim is to combine a concrete or a *type* of the whole, with an *enumeration* of the parts. This is in accordance with what has just been laid down, respecting the best method of rising from abstract elements to a concrete embodiment. Some comprehensive designation that may spread out the main features of the object is indispensable to the description; and within this, the details may be arranged in proper form and order. The following is a very simple instance from Milton, which seems as if it could not have been stated otherwise than he has done; but art shows itself in carrying into complicated cases the method that appears self-evident in easy cases. The words in italics mark the comprehensive designation or type, the rest of the description giving the details :—

> They plucked *the seated hills*, with all their load—
> Rocks, waters, woods—and by the shaggy tops
> Up-lifting, bore them in their hands.*

The power of bodying forth or realizing what is described in language, is one of the meanings of Conception, which is given by some writers in the list of intellectual faculties. The same power is also expressed by Imagination, although it does not amount to what is implied under this faculty. There are three different intellectual operations, all based upon

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* Carlyle's description of the town and neighbourhood of Dunbar, the scene of Cromwell's decisive victory over the Scotch, is rendered vivid and conceivable, in consequence of his always prefacing particulars and details by terms and epithets that are at once comprehensive and picturesque :—

'The *small* town of Dunbar stands *high and windy*, looking down over its herring boats, over its grim old castle, now much honeycombed, on *one of those projecting rock-promontories* with which that shore of the Firth of Forth is niched and Vandyked as far as the eye can reach. A beautiful sea; good land too, now that the plougher understands his trade; *a grim niched barrier of whinstone* sheltering it from the chafings and tumblings of the big blue German Ocean. Seaward, St. Abb's Head, of whinstone, bounds your horizon to the east, not very far off; west, close by, is the deep bay, and fishy little village of Belhaven; the gloomy Bass and other rock-islets, and farther, the hills of Fife, and *foreshadows of the Highlands*, are visible as you look seaward. From the bottom of Belhaven Bay to that of the next sea-bight our sense-perceptions—Memory, or the literal reproduction of something experienced; Conception, or the picturing of what is described, by means of a constructive operation; and Imagination proper, which implies the construction of something neither experienced nor presented to us in description by others. Although these operations progressively increase in difficulty, yet there is a common aptitude at the bottom. He that has the most vivid pictorial Memory, will have a corresponding facility in Conception, and in the still higher power of Imagination.

CONSTRUCTIVENESS IN SCIENCE.

17. The Abstractions, Inductions, Deductions, and Experimental processes of science, which we have already seen to be mainly dependent upon the workings of the law of similarity, afford likewise examples of Construction.

The first in order of the scientific processes is Abstraction, or the generalizing of some property, so as to present it to the mind, apart from the other properties that usually go along with it in nature. Thus a square in Euclid is an abstraction: in the world, squareness is always accompanied with other properties, making the concrete, or actual, square,—a square pane of glass, a square of houses, &c. We have already seen that the forming of these abstract ideas is generally a result of the identifying action expressed by the law of Similarity.

St. Abb's-ward, the town and its environs form a *peninsula*. Along the base of which peninsula, 'not much above a mile and a half from sea to sea,' Oliver Cromwell's army, on Monday, 2d of September, 1650, stands ranked, with its tents and town behind it, in very forlorn circumstances.

'Landward, as you look from the town of Dunbar, there rises, some short mile off, *a dusky continent of barren heath hills;* the Lammermoor, where only mountain sheep can be at home. The crossing of which by any of its boggy passes and brawling stream-courses no army, hardly a solitary Scotch packman, could attempt in such weather. To the edge of these Lammermoor heights David Leslie has betaken himself; lies now along the utmost spur of them, a long hill of considerable height. There lies he since Sunday night, in the top and slope of this Doon Hill, with the impassable heath continents behind him; embraces, as with outspread tiger-claws, the base line of Oliver's Dunbar *peninsula*.'

(See Similarity, § 34.) We have now to point out a class of cases, where a considerable constructive effort is required in addition to the force of identification. There are abstractions of a peculiar order of subtlety, which cannot be arrived at, or embraced by the mind, except through a constructive operation, adapted to the case by much study of the particular instances. Take, for example, the abstract idea of a gas. Here the material eludes the senses, and cannot be represented by an example, or an outline, like a mountain, or a circle, or a genus of plants. And if the individual gases are so difficult to represent, there must be a similar difficulty in attaining an idea of the property common to them all as a class. A case of this nature must be circumvented. When we have ascertained by experiment the properties of one gas, such as the air, we record them in the best language we can obtain, by comparison with the more palpable phenomena of solids and fluids. We find that the air is inert, and has weight; that it is elastic, like a spring: but that it is extremely light. Trying other gases we find similar properties to hold good. When, however, we experiment on the visible vapour of water, we find an absence of the elastic property belonging to air and invisible steam; in fact, this substance has nothing in common with aeriform bodies, but lightness or tenuity; and, in the exercise of our best discretion, we think it right to exclude it from the group, and embrace together only those that have the property of elasticity, or spontaneous expansion, constituting this the defining mark, or the abstract idea of the class.

By a similar process of groping, experiment, and the exercise of judgment, the scientific world has arrived at abstract conceptions of the subtle properties expressed by Heat, Electricity, Chemical affinity, Cell-reproduction, &c. The definitions of these attributes are constructions laboriously worked out. Nevertheless, the means of effecting them, so far as intellect is concerned, is still by the ordinary laws of association, which bring up to the view various facts, expressions, and comparisons, in order to make tentative combinations; and these are gradually improved upon, as their unsuitability to the particular phenomena is discovered on examination. An intellect well versed in the kind of conceptions necessary, and acting vigorously in the reviving of these by association, is naturally qualified for the work. Next to this, there is required a clear perception of the subject to be seized, for unless we are able to judge accurately of the fitness of the constructions proposed, we shall rest satisfied with something far short of the truth. In every kind of endeavour, this power of judging clearly is indispensable ; without it, the most copious intellectual resources are expended to no purpose.

Possessing thus the material of the construction and a clear sense of the fitness or unfitness of each new tentative, there is needed nothing but patience, or, as Newton termed it, 'patient thought,' to attain the highest construction that is attainable in the case. This is the moral or volitional property of constructiveness, which I pointed out at the outset, as entering along with the properly intellectual forces into the constructive faculty. The power of patient thought, when highly developed, may repose upon a strong congeniality of mind towards the subject in hand, a passion or fascination for the peculiar class of ideas concerned, such that these ideas can be detained and dwelt upon without costing effort. The mathematical mind, in addition to its intellectual aptitude for retaining and recovering mathematical forms, should have this congenial liking for these forms, in order to prepare it for original discovery. The number of trials necessary to arrive at a new construction, is commonly so great, that, without a positive affection, or fascination, for the subject, we should inevitably grow weary of the task. The patient thought of the naturalist, desirous of rising to new classifications, must repose on the liking for the subject, which makes it to him a sweet morsel rolled under the tongue, and gives an enjoyment even to the most fruitless endeavours. This is the *emotional* condition of originality of mind in any department. When Napoleon described himself as '*un homme politique*,' we are to interpret the expression as implying a man of the political fibre or grain, a character whose charm of existence was the handling of political combinations, so that his mind could dwell with ease in this region of ideas.

18. What has been said above, with reference to the Abstractive process of science, applies also to Induction, or the generalizing of propositions, or truths. This may be either a simple effort of the reproductive force of similarity, or there may be wanted a constructive process in addition. In generalizing the law of the bending of light in passing from one medium to another, Snell constructed a proposition by bringing in a foreign element, namely, the geometrical sines of the angles : he found that the degree of bending was as the sine of the inclination of the ray. This is a good example of the devices required to attain to a general law. A mind well versed in such foreign elements, apt to revive them, and disposed to dwell upon them, will be the most likely to succeed in the happy fetches and combinations that clench great principles of science.

19. In the processes of Deduction, by which general laws and principles are applied to the clearing up of particular cases, and the solving of problems, the same line of remark might be pursued. The mind being prepared beforehand with the principles most likely for the purpose, and having a vigorous power of similarity in that region, incubates in patient thought over the problem, trying and rejecting, until at last the proper elements come together in the view, and fall into their places in a fitting combination.

The vast structure of the mathematical sciences is a striking example of constructiveness, as distinguished from the discoveries of mere identification through the law of similarity. In Geometry, in Algebra, in the higher Calculus, and in the endless devices of refined analysis, we see an apparatus perfectly unprecedented, the result of a long series of artificial constructions for the working out of particular ends. It would not be difficult to trace out the course of this creative energy ; the mental forces involved in it being no other than those that we have been endeavouring to explain.

20. In the devices of Experimental science, there comes into play a constructiveness akin to invention in the arts and manufactures. The air-pump, for example, is an illustrious piece of constructive ingenuity. The machine already in use for pumping water had to be changed and adapted to suit the case of air; and it was necessary that some one well versed in mechanical expedients, and able to recall them on slight hints of contiguity, or similarity, should go through the tedious course of trials that such a case required.

Putting together the applications of the Retentive power of the mind in Science (Contiguity § 70), the explanation of the operations of Abstraction, Induction, and Deduction (Similarity § 34), and what has now been said as to the nature of the Constructive operation, we have an account, as complete as I am able to give, of the composition of the Reasoning faculty, viewed in its most comprehensive sense.

PRACTICAL CONSTRUCTIONS.

21. The region of inventions for the practical ends of life might be traversed for illustrations of constructive genius. So, the department of administrative capacity in every class of affairs, and every kind of business, might be explored with the same view.

Not one of the leading mental peculiarities above laid down as applicable to scientific constructiveness, can be dispensed with in the constructions of practice;—the intellectual store of ideas applicable to the special department; the powerful action of the associating forces; a very clear perception of the end, in other words, sound judgment; and, lastly, that patient thought, which is properly an entranced devotion of the energies to the subject in hand, rendering application to it spontaneous and easy.

In the case of originality in all departments, whether science, practice, or fine art, there is a point of character that is worth specifying in its place, as being more obviously of value in practical inventions and in the conduct of business and affairs, I mean an Active turn, or a profuseness of energy, put forth in trials of all kinds on the chance of making lucky hits. In science, meditation and speculation can often do much, but in practice, a disposition to try experiments is of the greatest service. Nothing less than a fanaticism of experimentation could have given birth to some of our grandest practical combinations. The great discovery of Daguerre, for example, could not have been regularly worked out by any systematic and orderly research; there was no way but to stumble on it, so unlikely and remote were the actions brought together in one consecutive process. The discovery is unaccountable, until we learn that the author had been devoting himself to experiments for improving the diorama, and thereby got deeply involved in trials and operations far remote from the beaten paths of inquiry. The fanaticism that prompts to endless attempts was found in a surprising degree in Kepler. A similar untiring energy—the union of an active temperament with intense fascination for his subject—appears in the character of Sir William Herschel. When these two attributes are conjoined; when profuse active vigour is let loose on a field which has an unceasing charm for the mind, we then see human nature surpassing itself; and, with the aid of adequate intellectual power, the very highest results may be anticipated. The greatest practical inventions being so much dependent upon chance, the only hope of success is to multiply the chances by multiplying the experiments.

The invention of Daguerre* illustrates—by a modern instance—the probable method whereby some of the most ancient inventions were arrived at. The inventions of the scarlet dye, of glass, of soap, of gunpowder, could have come only by accident; but the accident, in most of them, would probably fall

* The wonderful part of this discovery consists in the succession of processes that had to concur in one operation, before any effect could arise. Having taken a silver plate, iodine is first used to coat the surface; the surface is then exposed to the light, but the effect produced is not apparent till the plate has been immersed in the vapour of mercury. To light upon such a combination, without any clue derived from previous knowledge, an innumerable series of fruitless trials must have been gone through.

into the hands of men who had been engaged in numerous trials with the constituent materials. Intense application,—'days of watching, nights of waking,'—in all likelihood attended ancient discoveries as well as modern. In the historical instances, we know this to have been the case. The mental absorption of Archimedes is a proverb.

A remark may be made here, applicable alike to Science and Practice. Originality in either takes two forms, Observation or Experiment on the one hand, and the identifying processes of Abstraction, Induction, and Deduction on the other. The last are the purely intellectual forces; in the first, the bodily activities and the senses are involved. It is not by high intellectual force that a man discovers new countries, new plants, new properties of objects; it is by putting forth an unusual force of activity, adventure, inquisitorial and persevering search. All this is required to obtain the observations and facts in the first instance; when these are collected in sufficient number, a different aptitude is brought to bear. By identifying and generalizing the scattered materials, general properties and general truths are obtained, and these may be pushed deductively into new applications; in all which a powerful reach of Similarity is the main requisite; and this may be owned by men totally destitute of the active qualities necessary for observation and experiment.

22. The present topic furnishes a good opportunity for singling out, for more special notice, the quality of mind well known by the name of Judgment. I have already included a clear perception of the end to be served, as essential to a high order of constructive ingenuity, simply because without this, though there may be a great profusion of the requisite devices and suggestions towards the required combination, the fitting result is really not arrived at. Some combination short of the exigencies of the case is acquiesced in, and the matter rests.

The various regions of practice differ very much in respect of the explicitness of the signs of success. In some things there is no doubt at all; we all know when we have made a good dinner, when our clothing is warm, or when a wound has healed. The miller knows when there is water enough for his mill, and the trader knows when he has found out a good market. The end in those cases is so clear and manifest, that no one is deluded into the notion of having compassed it, if this is really not the case. But in more complex affairs, where perfect success is unattainable, there is room for doubts as to the degree actually arrived at. Thus in public administration, we look only for doing good in a considerable majority of instances, and it is often easy to take a minority for a majority in such a case. So in acting upon human beings, as in the arts of teaching, advising, directing, we may suffer ourselves to fall into a very lax judgment of what we have actually achieved, and may thus rest satisfied with easy exertions and flimsily-put-together advices. A sound judgment, meaning a clear and precise perception of what is really effected by the contrivances made use of, is to be looked upon as the first requisite of the practical man. He may be meagre in intellectual resources, he may be slow in getting forward and putting together the appropriate devices, but if his perception of the end is unfaltering and strong, he will do no mischief and practise no quackery. He may have to wait long in order to bring together the apposite machinery, but when he has done so to the satisfaction of his own thorough judgment, the success will be above dispute. Judgment is in general more important than fertility, because a man, by consulting others and studying what has been already done, may usually obtain suggestions enough, but if his judgment of the end is loose, the highest exuberance of intellect is only a snare.

The adapting of one's views and plans to the opinions of others is an interesting case of constructiveness, and would illustrate all the difficulties that ever belong to the operation. A more abundant intellectual suggestiveness is requisite, according as the conditions of the combination are multiplied; we must transform our plan into a new one containing all the essentials of success, with the addition that it must conform to the plan of some other person. There is in that case a considerable amount of moral effort, as well as of intellectual adaptation; the giving way to other men's views being by no means indifferent to our own feelings.

The subject of Speech in general would present some aspects of the constructive mechanism not hitherto brought to light in our exposition. A fluent speaker constructing verbal combinations adapted to all the exigencies of meaning, grammar, taste, and cadence, as fast as the voice can utter them, is an object interesting to study in the present connexion. The Italian Improvisatori furnish a still higher example. The sufficiently *rapid* action of the associating forces is here of prime importance. Real power is not usually identified with a specific pace of mental movement; a slow action may be as effective as a quick; but in this particular instance, the ready revival of all the associations that concur in the common stream is of vital importance.

FINE ART CONSTRUCTIONS.—IMAGINATION.

23. The grand peculiarity of the case now to be considered is the presence of an emotional element in the combinations. In the constructions of science and of practice, a certain end is to be served—the attainment of truth, or the working out of a practical result. And the mind has to choose means suitable to those ends, according to the rigorous laws of nature's working. A builder has to erect a structure that will defy wind and frost, and accommodate a certain number of human beings. Nothing must enter into his plan that is not calculated to effect these purposes. The construction is considered a pure effort of intellect, because it is by intellect that we comprehend the laws and properties of stone, wood, and iron, and choose out and combine such materials as will serve for warmth and shelter. We should not properly call this operation 'imaginative,' although there is a constructive process gone through; simply because no feeling or emotion enters in as an element, excepting the one feeling of answering a practical end. Volition there is in abundance,

but not emotion in the sense implied in the constructive processes of the imagination.

When, however, any practical construction, such as a building, in addition to the uses of shelter and accommodation, is intended to strike the refined sensibilities that we term the feeling of the beautiful, the grand, the picturesque, a turn must be given to the plan so as to involve this other end. Here we have emotion viewed in a certain narrow sense, as exclusive of direct utility for the wants and necessities of life. We have feelings of warmth, of repletion, of repose ; but these are not consulted in fine art. The securing of such pleasures as those, and the warding off the opposite pains, and all pains connected with our physical organs, are among the ends of practical art. When these practical ends are secured, there are other feelings and sentiments belonging to human nature that can be touched in a way to increase the sum of human happiness. These are variously called the pleasures of Taste, the æsthetic sensibilities, the emotions of Fine Art ; and combinations shaped with the view of gratifying them are called artistic, æsthetic, or imaginative compositions. In all such compositions, an element of fine emotion is the regulating power, the all in all of the creative effort.*

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* The following passage will aid us in working out the distinction between the constructions of imagination and the constructions of science and practice :—

'The trains of one class differ from those of another, the trains of the merchant for example, from those of the lawyer, not in this, that the ideas follow one another by any other law, in the mind of the one, and the mind of the other ; they follow by the same laws exactly ; and are equally composed of ideas, mixed indeed with sensations, in the minds of both. The difference consists in this, that the ideas which flow in their minds, and compose their trains, are ideas of different things. The ideas of the lawyer are ideas of the legal provisions, forms, and distinctions, and of the actions, bodily and mental, about which he is conversant. The ideas of the merchant are equally ideas of the objects and operations, about which he is concerned, and the ends towards which his actions are directed ; but the objects and operations themselves are remarkably different. The trains of poets, also, do not differ from the trains of other men, but perfectly agree with them in this, that they are composed of ideas, and that those ideas succeed one

24. In adducing examples of combinations controlled by an emotional element, I shall not confine myself to the narrowest class of artistic feelings, the feelings of Taste properly so called; the fact being that, even in the creations

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another, according to the same laws, in their, and in other minds. They are ideas, however, of very different things. The ideas of the poet are ideas of all that is most lovely and striking in the visible appearance of nature, and of all that is most interesting in the actions and affections of human beings. It thus, however, appears most manifestly, that the trains of poets differ from those of other men in no other way, than those of other men differ from one another; that they differ from them by this only, that the ideas of which they are composed, are ideas of different things. There is also nothing surprising in this, that, being trains of pleasurable ideas, they should have attracted a peculiar degree of attention; and in an early age, when poetry was the only literature, should have been thought worthy of a more particular naming, than the trains of any other class. These reasons seem to account for a sort of appropriation of the name Imagination to the trains of the poet. An additional reason may be seen in another circumstance, which also affords an interesting illustration of a law of association already propounded; namely, the obscuration of the antecedent part of a train, which leads to a subsequent, more interesting than itself. In the case of the lawyer, the train leads to a decision favourable to the side which he advocates. The train has nothing pleasurable in itself. The pleasure is all derived from the end. The same is the case with the merchant. His trains are directed to a particular end. And it is the end alone which gives a value to the train. The end of the metaphysical, and the end of the mathematical inquirer, is the discovery of truth; their trains are directed to that object; and are, or are not, a source of pleasure, as that end is, or is not, attained. But the case is perfectly different with the poet. His train is its own end. It is all delightful, or the purpose is frustrate. From the established laws of association, this consequence unavoidably followed; that, in the case of the trains of those other classes, the interest of which was concentrated in the end, attention was withdrawn from the train by being fixed on the end; that, in the case of the poet, on the other hand, the train itself being the only object, and that pleasurable, the attention was wholly fixed upon the train; that hence the train of the poet was provided with a name; that, in the cases of the trains of other men, where the end only was interesting, it was thought enough that the end itself should be named, the train was neglected.

'In conformity with this observation, we find that wherever there is a train which leads to nothing beyond itself, and has any pretension to the character of pleasurable (the various kinds of reverie, for example) it is allowed the name of Imagination. Thus we say that Rousseau indulged his imagination, when, as he himself describes it, lying on his back, in his boat, of the artist, all the strong emotions may come in to swell the current of interest, excepting only a few of the more exclusively animal feelings. Rage, terror, tenderness, egotism, are not æsthetic emotions, but still the artist uses them in his compositions. I should also remark that the influence of the emotions, while just and legitimate in the artistic sphere, is usually a source of corruption and bias in the combinations that have truth or practice for their end. This is only another way of saying that imagination is not to occupy the place of judgment and reason.

The emotion of Terror gives a character to all the ideas or notions formed under the influence of the feeling. A man once thoroughly terrified sees only objects of dread. It is difficult to form any combinations free of this element. Ghosts and hobgoblins fill the imagination of the superstitious, while more substantial forms of evil haunt the mind superior to the dread of the supernatural. The terrified imagination is powerful to form creations of terror, such as may prove an interesting excitement to the cool spectator, but which are also likely to vitiate the truth of any narrative of matter of fact given out under the influence of the moment. Hence

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on the little lake of Vienne, he delivered himself up for hours to trains, of which, he says, the pleasure surpassed every other enjoyment.

'Professor Dugald Stewart has given to the word Imagination a technical meaning; without, as it appears to me, any corresponding advantage. He confines it to the cases in which the mind forms new combinations; or, as he calls them, creations; that is, to cases in which the ideas which compose the train do not come together in the same combinations in which sensations had ever been received. But this is no specific difference. This happens in every train of any considerable length, whether directed to any end, or not so directed. It is implied in every wish of the child to fly, or to jump over the house; in a large proportion of all his playful expressions, as puss in boots, a hog in armour, a monkey preaching, and so on. It is manifested in perfection in every dream. It is well known that, for the discovery of truths in philosophy, there is a demand for new trains of thought, multitudes of which pass in review before the mind, are contemplated, and rejected, before the happy combination is attained, in which the discovery is involved. If imagination consists in bringing trains before the mind involving a number of new combinations, imagination is probably more the occupation of the philosopher than of the poet.'—MILL'S *Analysis*, vol. i. p. 181.

the accounts that a terror-stricken and routed army relate as to the numbers and power of the enemy on its heels ; hence the exaggerations that prevail in the public mind on occasions of popular panic. We see the power of an emotion, not merely to give its own character to the conceptions formed on all subjects, but, to induce belief in the full and exact reality of such conceptions.

With reference to examples of constructiveness of the class now cited, I may repeat the remark already made, to the effect that no new principle of association is at work in making an original combination; the only thing requisite being the presence or concurrence of the proper ingredients as furnished by the working of Contiguity and Similarity. When these ingredients appear in the mind together, they fall into their places as a matter of course. In the present instance, and in all imaginative, or emotion-ruled combinations, the laws of association can be proved to be sufficient to furnish the constituents of the combination; for we know that each strong feeling or passion has, associated with it in the mind, a large number of kindred objects, in consequence of the previous frequent companionship of such objects with the feeling. The passion of terror is connected with the things that have roused the feeling in the course of each one's experience ; one man has associations between it and a cruel parent or master, another with money losses, a third with attacks of illness, a fourth with defamation, a fifth with religious workings ; and most men are familiar with a plurality of causes of dread. When, therefore, the feeling is once excited, no matter how, these often experienced adjuncts rush up and possess the mind, and mix themselves up with the other ideas of the situation, so as to constitute a medley or compound of images, with terror as the predominating tone. Seeing the approach of a hurried messenger with distracted countenance, the trader's mind is already full of disasters at sea, or depressions of the market, the parent of a soldier is possessed of the calamities of warfare, the usurper is ready with the anticipation of a popular rising.

An exactly parallel illustration might be given from the passion of Anger. Once roused, this passion resuscitates the objects in harmony with it, and constitutes combinations wherein these enter as elements. The fanaticism of rage and hatred ascribes every diabolical impulse to the unfortunate object of the feeling; all the things that have customarily inspired anger are brought forward by contiguous association, and the instigator of the present outburst is looked on as guilty of innumerable crimes, in addition to the offence of the moment. This is an extreme case, but not unexampled in the history of the world. Party-rage brands opponents with the most unheard-of crimes; the term, calumny, only expresses this surplus of accusation against those that have excited the passion of hate.

25. The purely Egotistic feelings are remarkable for the superstructure of imaginative creations that they can rear. Self-complacency suggests merits and virtues, and constructs an estimate of self most flattering. Vanity sets up pictures of admiring assemblies and devoted worshippers. But most curious of all are the day-dreams of ambition in a sanguine temperament; these will embrace a whole history of the future, the baseless fabric of a vision of wonders and triumphs, which is not only constructed without labour, but whose construction no labour can arrest. In former sections, we have adverted to the difficult efforts of constructiveness; we have seen how hard it often is to comply with the numerous conditions that a construction must fulfil, or to give a place to all the ingredients that should be represented in it; so much so, that the attempt may have to be repeated time after time, before everything will fall into the proper place. A scientific man framing a definition for a very comprehensive class of objects, a mechanician constructing a new machine, a politician devising a state expedient, a general circumventing a hostile army,—will be each engaged in deliberations, for days or months, ere the proper combinations occur to the mind. One suggestion includes something to be avoided, another omits something that ought to be present, and long delays

and repeated substitutions and trials precede the successful termination of the struggle. But in the case now supposed, all is different: stupendous constructiveness, unbounded originality, flow out at once as fast as thought can evolve itself. Wherein lies the remarkable difference in these two forms of constructiveness? The immortal crockery merchant constructed, in a few minutes, a lengthened fiction, totally distinct from anything he had ever seen realized in actual life. Why has emotion such power? The answer is simple. A predominating emotion, such as Ambition, is every day at work associating itself with objects and incidents suited to gratify it. The feeling is called into play by every spectacle of power and grandeur that meets the eye, or is presented in story. The associating link is soon forged in the hot fire of passion; and, after months and years of indulgence of a favourite emotion, a rich growth of the corresponding objects and ideas is formed and ready to flow out, at any moment when the feeling is roused. Imagination in those circumstances, becomes a power needing restraint, rather than an effort of laboured constructiveness. The foregone associations with the feeling are so copious, that they present themselves freely for any purpose. Construction is easy where materials are abundant and the conditions few: the owner of the crockery basket had amassed pictures of happiness and grandeur, which required only to be cast into a consecutive order to make his epic, and an extempore effort was enough for this. The only condition was to satisfy one feeling; all restrictions were thrown aside, and he had plenty of images to suit the single emotion that lorded it over his dream. Very different would have been the pace of his execution, if he had insisted that this foreshadowing of his career should be in accordance with the stern experience of human life; if his picture should have been regulated by natural calculation, founded on known realities. This would have dried up his facility in a moment; he would then have been in the contrasting position, above described, of the man of science, or the man of business; a feeling might have still been the end, but purely intellectual estimates of the facts and laws of the world would have entered into his construction of the means. The reconciliation of his desires with the resources of his position would have been as arduous as a string of airy successes was facile. The process might have never so much of the constructive intellect, and the combination might have been never so original, but the term 'imagination' would no longer be used to describe it.

26. The Fine Art emotions, properly so called, the emotions of harmony, beauty, sublimity, picturesqueness, pathos, humour, become associated, in the artistic mind, with the objects that radiate the influence on the beholder, and from the materials thus stored up and reproduced by association the artist makes his constructions. I have in a former chapter (Contiguity, § 75) adverted to the mental equipment suitable to the artist in any department; and it is scarcely necessary to repeat, what I have endeavoured to illustrate throughout the present chapter, that, when all the elements are present that fit into a particular construction, they will take their places as a matter of course. The labour consists in getting up the constituent parts from the repositories of the mind, and in choosing and rejecting until the end in view is completely answered. Because the imaginations of a dreamer are easy and fluent, it does not follow that the imaginations of a musician, an architect, or a poet, shall be equally easy, although in principle the same, being governed by an emotion powerfully developed and richly associated with material. The artist has more stringent conditions to fulfil than the dreamer. He has to satisfy the reigning feeling of his piece,—the melody, harmony, pathos, humour,—of the composition; he has also to make this effect apparent to the minds of others; he has moreover to exclude many effects discordant to the taste of his audience; and, if his work be the decoration of some object of common usefulness, he has to save the utilities while in search of the amenities. Every new restriction adds to the difficulty of a combining effort; and an artist may be so trammelled with conditions,

that the exercise of imagination shall be rendered as laborious as any construction of the reason. To call up combinations that produce powerful and rich effects upon the minds of men, is not easy in any art; but the gathered abundance of the artistic intellect is the secret of the power. The more rich the granary of material, the more is the artist prepared to submit to the numerous conditions involved in a really great performance.

27. I do not purpose at present to enter upon a minute illustration of the mental processes of art-construction. Not only would a large space be requisite for spreading out the examples in detail, but there would soon come to be involved a strenuous polemical discussion, in consequence of the prevalence of theories of art that seem to me erroneous. Conceiving, as I do, that the first object of an artist is to gratify the feelings of taste, or the proper æsthetic emotions, I cannot assent to the current maxim that nature is his standard, or truth his chief end. On the contrary, I believe that these are precisely the conditions of the scientific man; he it is that should never deviate from nature, and who should care for truth before all other things. The artist's standard is *feeling*, his end is refined pleasure; he goes to nature, and selects what chimes in with his feelings of artistic effect, and passes by the rest. He is not even bound to adhere to nature in her very choicest displays; his own taste being the touchstone, he alters the originals at his will. The scientific man, on the other hand, must embrace every fact with open arms; the most nauseous fungus, the most loathsome reptile, the most pestilential vapour, must be scanned and set forth in all its details.

The amount of regard that the artist shows to truth, so far as I am able to judge, is nearly as follows. In the purely effusive arts, such as music or the dance, truth and nature are totally irrelevant; the artist's feeling, and the gratification of the senses of mankind generally, are the sole criterion of the effect. So, in the fancies of decorative art, nature has very little place; suggestions are occasionally derived from natural objects, but no one is bound to adopt more of these than good taste may allow. Nobody talks of the design of a calico as being true to nature; it is enough if it please the eye. 'Art is art because it is not nature.' The artist provides dainties not to be found in nature. There are, however, certain departments of art that differ considerably from music and fanciful decoration, in this respect, namely, that the basis of the composition is generally something actual, or something derived from the existing realities of nature or life. Such are painting, poetry, and romance. In these, nature gives the subject, and the artistic genius the adornment. Now, although, in this case also, the gratification of the senses and the æsthetic sensibilities is still the aim of the artist, he has to show a certain decent respect to our experience of reality in the management of his subject; that not being purely imaginary, like the figures of a calico, but chosen from the world of reality. Hence, when a painter lays hold of the human figure, in order to display his harmonies of colour, and beauties of form, and picturesqueness of grouping, he ought not to shock our feeling of truth and consistency, by a wide departure from the usual proportions of humanity. We do not look for anatomical exactness; we know that the studies of an artist do not imply the knowledge of a professor of anatomy; but we expect that the main features of reality shall be adhered to. In like manner, a poet is not great because he exhibits human nature with literal fidelity; to do that would make the reputation of a historian or a mental philosopher. The poet is great by his metres, his cadences, his images, his picturesque groupings, his graceful narrative, his exaltation of reality into the region of ideality; and if, in doing all this, he avoid serious mistakes or gross exaggerations, he passes without rebuke, and earns the unqualified honours of his genius.

28. The attempt to reconcile the artistic with the true,—art with nature,—has given birth to a middle school, in whose productions a restraint is put upon the flights of pure imagination, and which claims the merit of informing the mind as to the realities of the world, while gratifying the various æsthetic emotions. Instead of the tales of Fairy-Land, the Arabian Nights, the Romances of Chivalry, we have the modern

novelist, with his pictures of living men and manners. In painting, we have natural scenery, buildings, men, and animals represented with scrupulous exactness. The sculptor and the painter exercise the vocation of producing portraits that shall hand down to future ages the precise lineaments of the men and women of their generation. Hence, the study of nature has become an element in artistic education; and the artist often speaks as if the exhibition of truth were his prime endeavour, and his highest honour. It is probably this attempt, to subject imagination to the conditions of truth and reality, that has caused the singular transference above mentioned, whereby the definition of science has been made the definition of art.

Now, I have every desire to do justice to the merits of the truth-seeking artist. Indeed, the importance of the reconciliation that he aims at is undeniable. It is no slight matter to take out the sting from pleasure, and to avoid corrupting our notions of reality, while gratifying our artistic sensibilities. A sober modern romancist does not outrage the probabilities of human life, nor excite delusive and extravagant hopes, in the manner of the middle-age romances. The change is in a good direction.

Nevertheless, there is, and always will be, a distinction between the degree of truth attainable by an artist, and the degree of truth attained by a man of science or a man of business. The poet, let him desire it never so much, cannot study realities with an undivided attention. His readers do not desire truth simply for its own sake; neither will they accept it in the severe forms of an accurate terminology. The scientific man has not wantonly created the diagrams of Euclid, the symbols of Algebra, or the jargon of technical Anatomy; he was forced into these repulsive elements, because, in no other way, could he seize the realities of nature with precision. It cannot be supposed that the utmost plenitude of poetic genius shall ever be able to represent the world faithfully, by discarding all these devices in favour of flowery ornament and melodious metre. We ought not to look to an artist to guide us to truth; it is enough for him that he do not mis-guide us.

APPENDIX.

A.—*Definition and Divisions of Mind.*—p. 10.

In defining the department of Feeling, it will be observed that the negative method has been resorted to; it being implied that the positive definition is attended with difficulties. Were all feelings either pleasures or pains, the definition would be easy enough. But there are feelings indifferent as respects pleasure and pain,—for example, surprise, which may be pleasurable or painful, but which often is neither, and is yet a feeling of the mind. When we have occasion to draw a decided contrast between feeling and intelligence, we may quote pleasure or pain as unmistakable modes or examples of feeling, but we must not be understood as implying that there are no neutral, or indifferent, states.

In my former edition, I used the word 'Emotion' as a synonym of Feeling, on the ground that our so-called emotions—Wonder, Fear, Anger, Love—are generically identical with our Sensations; and that the fact implied by the word 'emotion,' namely, a certain stir of the bodily members, attaches to every thing that could be called a feeling, whether sensation or emotion. I was anxious to do away with the supposed distinction between states of feeling accompanied with bodily manifestations, and states not accompanied with such manifestations, which distinction I believe to be erroneous. Nevertheless, I am disposed to defer to the criticism of Mr. Spencer upon this point, and to confine myself to the word 'Feeling,' as the generic name, of which Sensation and Emotion are the two species. I have, accordingly, in this edition, ceased to employ the word 'emotion,' as the comprehensive name for the first department of the mind. With respect, however, to the adjective 'emotional,' used in contrast to the 'intellectual,' or the 'volitional,' I have not observed the same restriction. No adjective could be formed from the word 'feeling,' and yet it was often convenient to possess one. Thus, the senses are divisible into two classes, emotional and intellectual, meaning by the first, those where 'feeling' is the chief characteristic, and, by the second, those that minister to thought, or intellect.

I have also departed from the use of the word 'Consciousness,' employed in the former edition, as another synonym for Feeling. I employed that word for nearly the same reason as 'emotion' was used; namely, because whenever we are conscious, I believe that there is a physical accompaniment, essentially of the like nature, although perhaps in a lower degree, with the accompaniments of any salient emotion'; and, farther, because consciousness does not necessarily attend intellectual operations. But I now prefer to give to the word a greater extension than mind proper, and make use of it to include our object states as well as our subject states. The object and subject are both parts of our being, as I conceive, and hence we have a *subject-consciousness*, which is mind (the scope of mental science), and an *object-consciousness*, in which all other sentient beings participate, and which gives us the extended and material universe. Such a mode of employing the term I consider as highly serviceable in dealing with the great problem of Metaphysics.

Besides the classifications given in the text, I may quote that suggested by Mr. Samuel Bailey, although he has not made it the basis of a complete exposition of the mind. He adopts the usual three-fold partition, which he words as follows:—I. Sensitive Affections, comprising (1.) Bodily Sensations, and (2.) Mental Emotions. II. Intellectual Operations; enumerated as (1.) Discerning, (2.) Conceiving, (3.) Believing, (4.) Reasoning. III. Willing; subdivided into Willing operations of the Body, and Willing operations of the Mind.

B.—*Physical accompaniments of Pleasure and Pain.*—p. 301.

Mr. Herbert Spencer, in an Essay on Tears and Laughter, has suggested that the convulsive movements of the Diaphragm, in Laughter, are of a nature to lessen the action of the brain. 'The effort made is, not to take in more air, but to take in less. By a series of convulsive muscular contractions, the contained air is, as far as possible, expelled; a short inspiration follows, and then another series of convulsive movements; and so on, till the laughter ends; we being then, as we often significantly say, 'out of breath.' The result of this must be a temporary falling off in the absorption of oxygen; a corresponding diminution of vital activity; and, by implication, a decrease of that high cerebral excitement of which laughter is a consequence. In crying, too, which, as shown, is accompanied by excess of cerebral circulation, the action of the lungs is in essence the same. The long and forcible expirations, and the short inspirations which characterize it, must similarily cause deficient oxygenation and its results.' (Essays, first series, p. 400).

In a later work, Mr. Spencer has put forth an interesting speculation on the Physiology of Laughter, founded on an analysis of the physical accompaniments of feeling, in many respects identical with the view that suggested itself to me, as best in accordance with the facts.

He says: 'Strong feeling, mental or physical, being, then, the general cause of laughter, we have to note that the muscular actions constituting it are distinguished from most others by this, that they are purposeless. In general, bodily motions that are prompted by feelings are directed to special ends, as when we try to escape a danger, or struggle to secure a gratification. But the movements of chest and limbs which we make when laughing, have no object. And now remark that these quasi-convulsive contractions of the muscles, having no object, but being results of an uncontrolled discharge of energy, we may see whence arise their special characters—how it happens that certain classes of muscles are affected first, and then certain other classes. For an overflow of nerve force, undirected by any motive, will manifestly take first the most habitual routes; and if these do not suffice, will next overflow into the less habitual ones. Well, it is through the organs of speech that feeling passes into movement with the greatest frequency. The jaws, tongue, and lips are used only to express strong irritation or gratification; but that very moderate flow of mental energy which accompanies ordinary conversation, finds its chief vent through this channel. Hence it happens that certain muscles round the mouth, small, and easy to move, are the first to contract under pleasurable emotion. The class of muscles which, next after those of articulation, are most constantly set in action (or extra action we should say) by feelings of all kinds, are those of respiration. Under pleasurable or painful sensations, we breathe more rapidly, possibly as a consequence ot the increased demand for oxygenated blood. The sensations that accompany exertion also bring on hard breathing; which here more evidently responds to the physiological needs. And emotions, too, agreeable and disagreeable, both, at first, excite respiration; though the last subsequently depress it. That is to say, of the bodily muscles, the respiratory are more constantly implicated than any others in those various acts which our feelings, impel us to; and, hence, when there occurs an undirected discharge of nervous energy into the muscular system, it happens that, if the quantity be considerable, it convulses not only certain of the articulatory and vocal muscles but also those which expel air from the lungs. Should the feeling to be expended be still greater in amount—too great to find vent in these classes of muscles—another class comes into play. The upper limbs are set in motion. Children frequently clap their hands in glee; by some adults the hands are rubbed together; and others, under still greater intensity of delight, slap their knees and sway their bodies backwards and forwards. Last of all, when the other channels for the escape of the surplus nerve-force have been filled to overflowing, a yet further and less used group of muscles is spasmodically affected: the head is thrown back, and the spine bent inwards—there is a slight degree of what medical men call *opisthotonos*. Thus, then, the muscles first affected are those which feeling most habitually stimulates; and as the feeling to be expended increases in quantity, it excites an increasing number of muscles, in a succession determined by the relative frequency with which they respond to the regulated dictates of feeling.' (Essays, Second Series, p. 111.)

That the impulse that causes a feeling tends also to produce bodily movements, is to my mind incontestable. And I think that Mr. Spencer's remark as to the natural priority of the movements in muscles small in calibre and often exercised, (or, as he elsewhere expresses it, that the influence operates first in the line of least resistance), is sufficient to explain the selection of the features as organs of expression by pre-eminence. The tendency of the breathing functions to be soon affected, also falls under the same principle.

It appears to me, however, that Mr. Spencer, by omitting to study the difference of manifestations under pleasure and under pain, has not only left his theory incomplete, but has made statements that are too sweeping. He admits that disagreeable emotions in the end depress the respiration. He speaks of a few 'apparently exceptional cases, in which emotions exceeding a certain intensity produce prostration,' but maintains, nevertheless, that as a general law, alike in man and in animals, 'there is a direct connection between feeling and motion; the last growing more vehement as the first grows more intense.' My view is, on the contrary, that the law of increase of movements by increase of feeling, should be applied only to pleasurable feelings. I hold that when a stimulation is of a kind to cause pain, the general rule is, that it abates instead of causing movements. A blow sufficiently severe will bring the activity to a stand-still at any moment; a smaller blow will show itself in a partial stoppage of energy. I am not unaware of the exceptions to this rule; they have been dwelt upon in the text. But these exceptions are very far from subverting the rule to the extent of classing the painful and the pleasurable stimuli under one head. I agree with Mr. Spencer that force is never lost in the animal system, and that, in the case of every sensation, we should enquire—'where is all the nervous energy gone?' but I am at no loss to render a full account of the effects of a hurt; they are the destruction of the pre-existing energy of the system, the rupturing of the tissues, and the perverting of the natural functions. They are negative, or hostile influences; they put an arrest upon our movements, instead of increasing them. This arrest I look upon as the primary and proper effect of the agencies of pain; while the appearances of heightened energy that would seem to confound pain and pleasure, are but the occasional and temporary operation of another law of the animal organization.

Kant, in a passage quoted by Sir W. Hamilton (Metaphysics ii., 472), appears to have regarded pleasure as connected with Conservation. The following sentences, separated from a number of very confusing statements in the immediate context, are to this effect: 'Pleasure is the feeling of the furtherance (*Beförderung*), pain of the hindrance of life. Under pleasure is not to be understood the feeling of life; for in pain we feel life no less than in pleasure, nay, even perhaps more strongly. In a state of pain, life appears long, in a state of pleasure, it seems brief; it is only, therefore, the feeling, of the promotion,—the furtherance of life, which constitutes pleasure. On the other hand, it is not the mere hindrance of life which constitutes pain; the hindrance must not only exist, it must be felt to exist.'

Sir W. Hamilton has propounded a theory of pleasure and pain, substantially identical with the definition given by Aristotle, (Nicomachean Ethics, Book X.) It is summed up in these words: 'Pleasure is the reflex of the spontaneous and unimpeded exertion of a power, of whose energy we are conscious. Pain is a reflex of the overstrained or repressed exertion of such a power.' It is no part of my present plan to enter fully into the theory of pleasure and pain; the present discussion has been exclusively connected with the physical concomitants, which in all the theories quoted by Sir W. Hamilton, are mixed up with purely mental considerations. I will only remark that the theory of Aristotle, adopted by Hamilton, making pleasure the concomitant of the 'unimpeded energy of a natural power, faculty, or acquired habit,' by excluding passive pleasures (a warm bath, for instance), is obviously one-sided. The case is not bettered by giving to energy a meaning so wide as to include our passive sensibilities; the definition is thereby rendered so vague as to be quite worthless. The adoption of such a theory is interesting only as throwing light on the individuality of the holder.

C.—*The Germs and the Development of Volition.*—pp. 311, 421.

In a note (p. 415) I have given observations made upon two new-born lambs, as illustrating the origin and progress of voluntary power. I have since had opportunities of making observations on the first movements of the calf, which bore out the main points stated in the other case. It was a matter of ocular demonstration, that the new-born calf at first knew not which way to move to approach the cow, and had no notion whatever of the udder or of its whereabouts.

I have interrogated shepherds as to the circumstances attending the birth of lambs, and especially as to their ability to find out for themselves the mother's teats. I have been told in reply, that when the ewe and the lamb are both vigorous, they come together very soon of their own accord; but if one, or other, or both, are weakly, assistance must be given, otherwise the lamb is in danger of perishing before it can find its way to the teat. This was the most pertinent statement that I could elicit, and it is strongly confirmatory of the general doctrine advanced in the text, namely, initial spontaneity working under trial and error, the successful strokes being clenched and sustained under the law of conservation. Great physical vigour in the lamb is necessarily accompanied with an abundant spontaneity, the essential condition of a favourable start or commencement in the process of volitional acquisition.

I have stated, under the title of the principle of Self-conservation, what I deem the primitive link that connects action with feeling. This has been expressed by Mr. Spencer, with reference to the lowest forms of life, in the following terms:—'Thus, there is not a little reason to think, that all forms of sensibility to external stimuli, are, in their nascent shapes, nothing but the modifications which those stimuli produce in that duplex process of assimilation and oxidation which constitutes the primordial life. No part of the tissue of a zoophyte can be touched, without the fluids diffused throughout the adjacent parts being put in motion, and so made to supply oxygen and food with greater rapidity. Nutritive matter brought in contact with the surface, which, in common with the rest of the body, assimilates, must cause a still greater excitement of the vital actions; and so must cause the touch of organic substances to be more promptly responded to than that of inorganic substances. A diffusion of nutritive matter in the form of an odour will tend, in a slight degree, to produce analogous effects.' (Psychology, p. 403.)

Mr Spencer has not, as it seems to me, made the full use of the above hypothesis in his subsequent explanations of the growth of volition. Such an assumption is requisite in order to explain why certain movements, out of a great number happening, are retained by preference, so as to enter into a cohering union with definite states of feeling.

D.—*Seat of revived impressions.*—p. 343.

The following additional illustration, regarding the physical seat of revived impressions, is given by Wundt. 'If we look long at green light, a white surface, when we turn to it, appears red; if we look long at red light, the white surface appears green. Thus, every picture of an external object leaves behind it an after-picture, which has the same outline as the original picture, but is seen of the complimentary colour of the original. Now, a picture of the fancy leaves, though generally much less intensely, an after-picture too. If, with the eye closed, a picture of very lively colour is for a long time steadily held fixed before the fancy, and the eye be then suddenly opened and turned upon a white surface, the picture of the fancy is seen upon the white ground for a short time of a colour the complement of the original. This can take place, only because the eye has been wearied by the sameness of the colour of the picture of the fancy, and needs to seek relief in its complement, just as it would do with a real coloured object before it. The experiment proves that the nervous process in both cases is identical.' Kant, in one of his minor works, wishing to oppose the opinion that the soul or thinking principle resides only in the brain and in one part of it, meets the argument adduced from the feeling we have in the head in hard thinking, as follows:—'What causes the thinking soul to be felt chiefly in the brain, is perhaps this. All thought requires the mediation of *signs*, which may support the ideas to be aroused and give them the necessary degree of clearness. Such companion signs for our ideas are for the most part obtained through hearing and sight, both which senses are set in action by the impressions in the brain, since their organs lie nearest to it. If, now, the rousing of these signs, called by Des Cartes *ideæ materiales*, be properly a stimulation of the nerves to an activity resembling that which formerly brought about the sensation, the tissue of the brain in the act of thinking will fall to be affected in harmony with former impressions, and thereby become exhausted.' Here we have a partial recognition of the theory contended for in the text.

Sir W. Hamilton maintains substantially the same view in the following passage:—'I shall terminate the consideration of Imagination proper by a speculation concerning the organ which it employs in the representation of sensible objects.' 'But experience equally proves that the intercranial portion of any external organ of sense cannot be destroyed, without a certain partial abolition of the Imagination proper. For example, there are many cases recorded by medical observers of persons losing their sight, who have also lost the faculty of representing the images of visible objects. They no longer call up such objects by reminiscence, they no longer dream of them. Now, in these cases it is found that not merely the external instrument of sight—the eye—has been disorganized, but that the disorganization has extended to those parts of the brain which constitute the internal instrument of this sense, that is the optic nerves and thalami. If the latter, the real organ of vision, remain sound, the eye alone being destroyed, the imagination of colours and forms remains as vigorous as when vision was entire.' 'But not only sensible perceptions, voluntary motions likewise are imitated in and by the imagination. I can, in imagination, represent the action of speech, the play of the muscles of the countenance, the movement of the limbs; and, when I do this, I feel clearly that I awaken a kind of tension *in the same nerves* through which, by an act of will, I can determine an overt and voluntary motion of the muscles; nay, when the play of imagination is very lively, this external movement is actually determined.'—(Metaphysics ii. 169, 274.)

I quote farther a few sentences from Mr Spencer's theory of Memory. 'To remember the colour red, is to have, in a weak degree, that psychical state which the presentation of the colour red produces; to remember a motion just made by the arm, is to feel a repetition, in a faint form, of those internal states which accompanied the motion—is an incipient excitement of all those nerves whose stronger excitement was experienced during the motion.'—(Psychology, p. 359.)

E.—*Perception of the Material World.*—p. 387.

I shall here advert to the mode of solving this great problem agreed on by some of the most distinguished philosophers of the present day.

Sir W. Hamilton has examined the subject at great length, recurring to it in many parts of his writings. I select the following quotation as sufficiently expressing his views:—'In the act of sensible perception, I am conscious of two things—of *myself* as the *perceiving subject*, and of an *external reality*, in relation with my sense, as the *object perceived.* Of the existence of both these things I am convinced; because I am conscious of knowing each of them, not mediately in something else, *as represented*, but immediately in itself, as *existing*. Of their mutual dependence I am no less convinced; because each is apprehended equally and at once, in the same indivisible energy, the one not preceding or determining, the other not following or determined; and because each is apprehended out of, and in direct contrast to, the other.' —(*Reid*, p. 747.) Here it is maintained that conciousness tells us at once that there is a world external to, and independent of, the world of mind, being known by its contrast with mind.

Mr. Samuel Bailey, in his *Letters on the Philosophy of the Human Mind*, has exposed, with great clearness and force, the equivocations of language and confusion of ideas that have clouded the question of external perception. His own view is expressed in the following sentence—'It seems to have been only after a thousand struggles that the simple truth was arrived at, which is not by any means yet universally received—the truth that the perception of external things through the organs of sense is a direct mental act or phenomenon of consciousness, not susceptible of being resolved into anything else.'—p. 111.

Mr. Herbert Spencer, after reviewing the whole question at length (Principles of Psychology, Part I.) arrives at the following conclusion—'These positions being granted, it inevitably results, as we have found, that the current belief in objects as external independent entities, has a higher guarantee than any other belief whatever—that our cognition of existence considered as noumenal, has a certainty which no cognition of existence, considered as phenomenal, can ever approach; or in other words—that, judged logically as well as instinctively, Realism is the only rational creed; and that all adverse creeds are self-destructive.'—p. 59.

Now, with regard to this theory of Realism, so emphatically vindicated by these three great speculative thinkers, I must still take leave to demand the *meaning* of an external and independent reality. If the answer be, that this also is given to us in consciousness, as a simple, ultimate, unanalyzable, inexplicable notion, like colour or heat, I dispute the assertion. I deny the ultimate nature of each of the three notions—'external,' 'independent,' and 'reality.' Every one of them admits of being explained, analyzed, or resolved into other notions. The idea of 'externality,' as applied to the object world, is a figurative employment of the notion that we obtain in our experience of extended things. We see an extended object—as a field, with some cattle grazing within its enclosure, and others grazing without—and by comparing all such experiences, we obtain the idea of externality, which we apply to the object-world as compared with the subject-world. The application is, at best, but figurative; the cases are, to my mind, not strictly parallel. The parallelism applies properly to our bodies as compared with surrounding objects; it applies to mind only by the questionable mode of representing the mind as an organ enclosed in the body.

Again, how do we come by our notion of 'independent?' Is it not by a study of the complicated arrangements of the world about us? This is far from an elementary idea. Children do not understand it at first. It is an abstraction from a certain class of facts gradually disclosed in our experience. Moreover, it is applied to the relation of subject and object, with still less of relevance than the foregoing. Indeed, this is the word that has insinuated into men's minds that erroneous opinion, which Berkeley criticised, and which has had to be abandoned—the theory of a world existing apart from mind, but, coming into contact with mind, so as to impress thereon images or ideas of itself. Not only is the word inapplicable, as it seems to me, but the application of it is opposed to the facts of the case. 'Independence' is neither an ultimate conception or notion, nor a suitable derived conception, in the present instance.

Lastly, I would appeal to any candid person, to say, if 'reality' is a simple, unanalyzable notion, fit to enter into an axiomatic or ultimate truth of consciousness. It is an exceedingly subtle and complex notion, obtained from the examination of a wide range of facts. The term is very vaguely understood by the generality of persons. As applied to the theory of perception, it is obscure in an especial degree.

Thus, then, I object to the Realistic creed as presenting to us a statement involving terms of complex and derived signification, of doubtful meaning, and of unsuitable application. I cannot call the theory altogether false, any more than I can call it true. It is simply irrelevant. It is a crude figurative mode of expressing the greatest distinction that we can draw within our conscious life; it suits the commoner purposes of mankind; but is, in my opinion, altogether unworthy of the name of philosophy.

I have made an attempt, in the text, to arrive at an analysis of the great and radical contrast of the Object and the Subject. I consider that, before invoking consciousness to attest a fact, the fact itself should be reduced to its primitive and indivisible elements. Such doctrines as an External world, the Freedom of the Will, a Moral Sense, are not in a shape to be submitted to the test of our consciousness, as I have endeavoured to point out elsewhere (Emotions and the Will, p. 561.) The truths of consciousness ought to be axiomatic in the strict sense of the word; they should involve only ultimate notions.

I am well aware that this analysis has not given universal satisfaction. The following is an example of the kind of criticism it has met with.

"According to this, to see the sun in the heavens is to believe that, if we could only keep on walking long enough, we might burn our fingers; to descry the lark aloft, is to recite, by muscular sympathy, the beating of its wings since it left its nest; to think of any distant space, is to run over our locomotive sensations in reaching it, and the opportunity of thrusting out our own arm, when we have got there. Emptiness means simply scope for muscular exercise; and the infinitude of space imports only potential gymnastics for us under all conceivable circumstances. This kind of analysis of our ideas, seems to us, we must confess, a cruel operation—a cold-blooded dissection of them to death. The *disjecta membra*, given as their equivalents, and strung together in succession to replace the original whole, defy all identification. Look down an avenue of trees, and consider whether, in appreciating its perspective, you are engaged on the mere imagination of touches or the computation of fatigue?"

I must leave the reader to judge whether a philosophical analysis is to be refuted by the epithets 'cruel' and 'cold-blooded,' even if truly applied. Scientific explanations have often a repulsive and disenchanting effect; and the scientific man is not made answerable for this. In those sentences where the critic denies the adequacy of the analysis, I am bound to furnish a reply.

When I walk down an avenue of trees, the import of what happens to me is contained in these four particulars: I am putting forth muscular energy; my sensations of sight are changed in accordance with my muscular energies; the sensations of my other senses arise in the same uniform connexion with my energies; and, lastly, all other beings are affected in the same way as myself. When I look down the avenue, without walking down, the sight alone reveals all those facts, owing to frequent association, and reveals no other facts. It tells me what would happen to me, and to any other beings constituted like me, if we were to walk down. It recalls the actual experiences of conjoint energies and sensations, in the past, and anticipates the like in the future. This I take to be the simple revelation of consciousness, and all that consciousness can reveal, or that it concerns us to know. If an external and independent reality means anything besides those muscular feelings and sensations, and their mutual dependence, it is something that I am unable to imagine, and that would serve no end. People, no doubt, will ask, is the external universe merely an appendage of the collection of minds, vanishing when they are gone? Are we to believe that if all mind were to become extinct, the annihilation of matter, space, and time would result? I reply, this is not a fair statement of the case. I may, if I please, still speculate upon the certainty of an extended universe, although death may have overtaken all its inhabitants. But my conception, even then, would not be an independent reality, I should merely take on the object consciousness of a supposed mind then present. I should conceive nothing but states of muscular energy, conjoined with sensation.

Of the four particulars contained in the analysis, the last is what has most contributed to suggest the externality and independence of our object consciousness. When other beings are found to be affected by the same sensations, on performing the same movements, there appears to be an elimination of personality, or of all special or individual characteristics. We think we cannot mark the contrast strongly enough, by any process short of cutting each one's being into two parts, and depriving it of the part held by us in common, because it is in common. But I still contend, that the separation is only a figure of speech, which, like many other figures, has a Rhetorical use while involving a contradiction in logic. The past existence and future persistence of the object universe can mean to us only that if minds existed in the past, and are to exist in the future, they would be affected in a certain way. My object consciousness is as much a part of my being as my subject consciousness is. Only, when I am gone, other beings will sustain and keep alive the object part of my consciousness, while the subject part is in abeyance. The object is the perennial, the common to all; the subject is the fluctuating, the special to each. But there is nothing in the fact of community of experience (the object) that justifies us in separating the experience from the alliance with mind (the subject).

The new Realism is little better than the old popular notion, with Berkeley gagged.

F.—*Contiguous Association in the ideas of Natural Objects.*—p. 410.

The critic of this work in the 'National Review' has represented 'this order of derivation, making our objective knowledge begin with plurality and arrive at unity,' as 'a complete inversion of our Psychological history.' He considers, in opposition to the explanations in the text, 'that each state of consciousness, whether awakened through more or fewer channels, is, during its continuance, originally simple, and resolves itself only by change of equilibrium.' 'Experience proceeds, and intellect is trained, not by Association, but by *Dissociation*, not by reduction of pluralities of impression into one, but by the opening out of one into many.'

I was perhaps wrong in not guarding my exposition in the place alluded to, by the statement, that I was illustrating not the first steps of all in our cognition of things, but a later stage in our education, when we have obtained our elementary conceptions of body and are engaged in combining these in all the varieties presented by nature. In treating of the first origin of our notions of form, colour, hardness, &c., a very different line of remark from that in the text, would have to be pursued. But we soon arrive at a period of life when these notions are formed, and when we recognise any new concrete object presented to us, a building, for example, as a compound of form and effects of colour, and lay it up in our memory by the association of those notions. The education of the mineralogist, botanist, zoologist, proceeds, at the stage I am supposing, by association wholly. The objects of their several studies are aggregates of qualities in the sense of the text. I supposed the primary constituents of the different conceptions to have been obtained by the mind, which is the condition recognised by the critic as enabling the principle of Association to come into play.

I have, in various parts of my two volumes, discussed the primary origin of our ideas, so far as we are able to reason back to the dawn of intelligence; and, in the concluding chapter of the Emotions and Will, I have dwelt upon the fundamentals of cognition, some of my statements on that subject obtaining the approval of the same reviewer. But I am bound to mention, that my able contemporary, Mr Spencer, has, while adopting substantially the same views as mine, developed this part of the subject with a systematic completeness peculiar to himself. (Psychology, Part ii., Chapters on Perception, 9-17.

It must be admitted, as the critic remarks, that the first presentation to consciousness of an object, afterwards accounted complex, does not necessarily give a feeling of complexity. The first effect of any new presentation is an indefinable shock to the mind, a rousing of consciousness, by the mere circumstance of change of impression. It is impossible to describe this consciousness as either single or complex; it is better considered as purely vague. If the state passes away, and, after an interval when the mind has had other shocks, is reproduced, there arises with it the consciousness of identity, or recognition, which is a step towards determining and defining its character. If it is a sensation of cold, we are led by it to reinstate the previous states of cold, and the comparison has the effect of singling out and detaching this experience from others, an effect already commenced by the consciousness of the difference between it and other states. No long time is necessary to recognize the complexity of our sensations; for, if we see a fire, and feel the warmth, we dissociate the conjunct impression by identifying the sight with former impressions of the same colour, and the warmth with former experiences of warmth. As soon as we have a *past* to refer to, however limited, we separate every compound sensation into its elements. If the first sensation that combined light and warmth be vague and unanalyzable, two or three experiences, where these occur in different connexions, would lead to a commencement of the disentangling consciousness. Each element in a compound would recall the previous impressions of that element; heat would bring up heat, blackness would go upon the old track of blackness, and so on. We cannot tell how soon this process would be distinctly possible; it matters little what the precise lapse of time is; we can see that the mind after an experience, longer or shorter, must arrive at the state representing our habitual conduct in the matter, namely, that every complex sensation is instantaneously taken to pieces by filing every separate ingredient on its own thread. The round figure of a pebble revives the accumulated impression made by all experiences of roundness; the colour is fused with all the previous impressions of that colour; the hardness brings back the sum total of traces of the same hardness, and so on. Hence, Mr Spencer justly describes perception as a process of *classification*.

Of course there can be no perception until some accumulation of separate impressions has taken place; but it cannot be long ere we are prepared to make a beginning in the work. As a compositor distributing types effectually disintegrates his compound impression of a word, by tossing an *a* with the *a*'s, and an *n* with the *n*'s, so we require a foregone reference for each item of a compound sensation; but when this has been obtained by means of our growing stock of agreeing impressions, we are prepared for the work of combining and associating in the manner attempted to be explained in the text.

G.—*Abstraction, and Abstract Ideas.*—p. 527.

The mental nature of abstract ideas, after all that has been written on it, is still an unexhausted theme of controversy. Philosophers, having started from the Platonic 'ideas,' and the Peripatetic 'universals,' were long in divesting themselves of those fictitious essences. No one seems to me to have expressed the truth on this subject, more clearly than Mr. Bailey, in his Letters on the Mind. I quote from him the following sentences—'Hence, in my view, all the general and abstract ideas, notions, and conceptions, which make so great a figure in speculation, are mere fictions, and the terms which are regarded as denoting them, highly useful and important and indispensable as they are, can raise up in the mind none but particular representations, and are only expedients, although most valuable expedients of language. Our idea of life is nothing but the idea of something living; of truth but of something true; of causation, but of something causing; of time, but of something lasting; of space, but of something extended.'—(Second Series, p. 77.)

The mental embodiment of an abstract idea, the material of it, so to speak, must be some of the particulars, or some concrete instances of the property generalized. The notion of justice cannot be conceived or understood otherwise than by a reference to some just actions. This necessity of reverting to particulars is, to appearance, evaded in some instances. Thus, in Geometry, we introduce naked forms—lines, triangles, and circles—bereft of all substance, body, or matter. Still, however, these are particular instances of the abstract notions, only greatly attenuated as regards the substance. Another apparent evasion is the verbal definition, which applies only to the quality in the abstract, and excludes the mention of the accompaniments in the concrete. 'A line is length without breadth.' This is a perfectly idealized representation of a line, and may be called a pure abstraction. But, although we may construct a definition to exclude breadth, our conception must include it; we must have before us some line in the concrete.

The full mastery of abstract ideas really includes a string of particulars in each case, sufficient to represent the property in all its compass and variety. When we make a proposition, we make it of these particulars; we run over the list to see that our predicate is not repugnant to any one of them. We must have within call a sufficient number of concrete instances to prevent our making an affirmation not borne out by all of them. Hence an abstract reasoner may be said to be a man of more than ordinary command of particulars in the concrete. No one can reason accurately about government in general, without a very intimate familiarity with governments in particular.

There is an ambiguity connected with the words class and classification, which has a bearing upon the theory of reasoning. In popular language, any objects that have been generalized are spoken of as a class; wise men, just actions, good governments, would be called classes. But, in a stricter sense, a class is a generalized group actually brought together in a collection, or a catalogue, so that we know by inspection whether a certain individual is included or not. Thus geography classes the seas, the mountain ranges, the rivers, &c., by actual enumeration. So it is in Natural History. The classes are enrolled in books, and represented by specimens in museums. Generalization is the principle adopted for placing, or arranging, a multitude of things actually possessed. We should not be able to get the word confined to this stricter meaning, but it has to be borne in mind, in discussing the nature of general propositions, and the foundations of deductive reasoning. (See Mill's Logic, Book I., Chap. V., § 3.)

Space and Time.

Of all abstract motions, these are about the most difficult to trace, being also the most fundamental. As their discussion in the text has been scattered under different heads, I may here add a few remarks respecting them.

The word 'space' has two meanings, and I may not always have been able to avoid the confusion arising from this ambiguity. It may mean the Extended Universe, including extended matter, or it may mean empty space, to the exclusion of matter. I have generally preferred to employ 'the Extended' for the first meaning, and 'empty space,' for the second. But in metaphysical discussion, Space usually signifies the extended universe.

The origin of our notion of the Extended, the characteristic property of the object world, has been traced in its successive stages, under the heads of Muscular Feeling, (p. 112), Touch, (p. 197), Sight, (p. 250), External Perception, (p. 370). It will, of course, be inferred that I do not regard it as an intuition of the mind, a form of thought, or an element transcending our actual experience. By such steps as I have endeavoured to describe, we derive our notions of extended things,—of extension in the concrete. And from this we can obtain an abstract notion of the extended, in the same manner as we gain any other abstract notion, as colour, heat, or justice.

The Kantian doctrine, which regards Space and Time as forms of thought, and not products of our experience, has been examined and, as I think, decisively refuted by various writers, among whom I may name Mr. Spencer (Psychology, pp. 52, 244, 309) and Mr. Bailey (Letters on the Mind). I do not here propose to argue the point. My plan has been to exhibit what seems to me the genesis of the notion; and if that is satisfactory to the reader, an *a priori* origin is disproved by being superseded. The objections urged by Locke against innate notions generally have never, to my mind, been repelled; and they have been re-inforced since his time. It may be granted, however, that Locke did not succeed in explaining how we come by such notions as Space, Substance, and Power. The five senses, as commonly understood, are inadequate to the purpose. I am satisfied, however, that when the muscular feelings are fully taken into the account, the difficulty exists no longer. The *a priori* notion of space has a shadowy and evanescent character in the hands of Sir W. Hamilton, who concedes an *empirical* knowledge of extension, as an element of existence.' He proposes to give 'the name *extension* to our empirical knowledge of space, and to reserve the name of *space* for space considered as a form, or fundamental law of thought.' I confess myself altogether unable to follow him in constituting a difference between extension and space.

There is an exact parallelism between Space and Time, as regards the genesis of our notions of each. Time is endurance in the abstract; and the abstract notion is, as in all other cases, grounded on concrete examples of duration. Time is a property common to both Subject and Object; the sense of degrees of continuance attaching to all our feelings, although it is from external movements that we are enabled accurately to estimate it.

I.—*Classifications of the Intellectual Powers.*

The Intellectual powers were classified by Reid as follows:—*External Senses; Memory; Conception*, or Simple Apprehension; *Abstraction*, under which he discussed the questions of Nominalism, Realism, &c.; *Judgment*, or the theory of Common Sense as a basis of truth, the distinction between Necessity and Contingent Truth, &c.; *Reasoning*, which contains under it Demonstration and Probable Reasoning; *Taste*. He does not specify Imagination, nor allude to it, except indirectly under Taste.

Dugald Stewart added to the above scheme Consciousness, Attention, Association of Ideas, and Imagination; and omitted Taste. His enumeration stands thus:—*Consciousness; External Perception; Attention; Conception; Abstraction; Association of Ideas; Memory; Imagination; Reasoning.* Under the last-named head, Reasoning, he discusses matters principally appertaining to Logic; the nature of Belief, Evidence, Demonstration, the Aristotelian Syllogism, and Induction.

These two schemes are liable to a common objection. They are not an analysis of our intellectual operations; they do not separate the intellect into its different functions, supposing it to have a plurality of functions. They are merely the popular designations for the employment of the intellectual powers in certain distinct departments of activity; as, for example, Imagination for Fine Art, Reasoning for Science, Memory for intellectual acquisition generally. They farther agree in containing matter irrelevant to the science of mind.

Reid is specially chargeable with the anomaly of including the feelings of Beauty, &c., in the intellect. The only remedy for this would have been to adopt the three-fold partition of the mind.

Stewart has committed the irregularity of placing an exercise of volition among the intellectual faculties, namely, Attention. In introducing the Association of Ideas, he has fallen into the error, pointed out by Mr. Bailey (Letters on the Mind, First Series, p. 72), of placing the same subject on two foundations. The Association of Ideas, if good for anything, is competent to supersede Memory, Reason, Imagination, &c., by explaining all the phenomena that these severally imply. It cannot, therefore, be co-ordinate with these powers.

Sir. W. Hamilton gives six Intellectual Faculties: *Presentative*, including the Senses, and Self-consciousness as the knowledge of mental phenomena; *Conservative*, or memory; *Reproductive*, depending on the Laws of Association; *Elaborative*, or Abstraction and Reasoning; *Representative*, or Imagination; and *Regulative*, which includes the instinctive sources of truth. The first of these, the *Presentative*, recognizes the senses as the first source of our ideas, and is merely another form of prefacing Intellect by Sensation. The second department of the Presentative relates to the knowledge of mental, or subject states, as sensation is supposed to relate to object states. Stewart thought it necessary to specify, in like manner, the source of our mental knowledge, by giving 'consciousness' at the head of his enumeration. There is a theoretical completeness attained by this plan; but the explanation in detail of the nature of the self-conscious, or introspective, faculty is inadequate in both writers. It is a matter of great subtlety. I have endeavoured to handle it, to the best of my power, in a late stage of the exposition of the Intellect. (Contiguity, § 71, p. 448.)

Hamilton's *Conservative* Faculty, taken by itself, would be another name for Memory or Retentiveness. But when we take this with the third in the list, the *Reproductive*, including the Laws of Association, a very serious objection arises. Of Conservation apart from Reproduction, we know nothing. That I have a thing in my memory, means that, on a certain prompting, I can reproduce it, or make it present. Conservation without reproduction would be a nonentity; reproduction carries with it whatever we mean by conservation. Then, the criticism above made with reference to Stewart's 'Association of Ideas,' applies equally to Hamilton. If he makes Reproduction a power of the mind in the sense of Association, he might explain by means of it the *Elaborative*, or scientific, faculty, and the *Representative*, or Imagination. By the *Regulative* faculty, Hamilton means what Reid calls Common Sense, or Instinctive Judgments, and what has also been called the 'Reason,' in a certain peculiar acceptation, in which it renders the Greek *νους*, and the German *Vernunft*. It is the source of the *a priori* principles of the mind; and Hamilton discusses under it the 'Law of the Conditioned,' which he more especially developes into a theory of the instinctive belief in Cause and Effect. This law corresponds in a great measure to the principle of Universal Relativity, a principle applied, in like manner, by Mr Spencer to the theory of causation. (First Principles, p. 241.)

Mr. Bailey's classification of the powers of the Intellect is given above (A). He proposes a division into four genera, with species under each. I. *Discerning*, divided into Sense-discernment, and discernment not through the senses. This corresponds to Sir W. Hamilton's Presentative Faculty. Under the second kind of discernment, I presume he would include, introspection, or self-consciousness. II. *Conceiving*, that is, having ideas or mental representations. There are three species of this power. (1.) Conceiving without individual recognition. (2.) Remembering, conceiving, with individual recognition. (3.) Imagining, or conceiving, under new combinations. III. *Believing*; (1.) on evidence, and (2.), without evidence. IV. *Reasoning*, of two kinds, Contingent and Demonstrative.

As Mr. Bailey has not made this scheme the basis of a full exposition of the mind, we are not in a position to judge fully of its merits. I should be disposed to differ from him as to the placing of Belief among intellectual operations, for reasons stated elsewhere. Apart from this, the classification is open to the same objection (if the author would consider it an objection) as all the foregoing; there is no analysis of the ultimate and distinct properties or functions of the intellect; the divisions are not mutually exclusive. Imagining and Reasoning are not separate functions, but the same functions and powers applied differently. It seems to me requisite to present such an analysis, in the first instance, in order to see what our intellectual powers really are; and then to trace the workings of these in such operations as Memory, Reasoning, and Imagination.

Mr. Spencer, in his Essays (Second Series, p. 139), has indicated a classification to the following effect. He speaks of the Intellect under the name of COGNITIONS, which he defines as the *relations* subsisting among our Feelings, and divides into four sub-classes. I. *Presentative Cognitions*, by which he means the localizing of sensations in the body, as in knowing, when hurt, what is the part affected. II. *Presentative-representative* Cognitions, by which is meant the perception of things in wholes from the sensation of some of their constituents, as when the sight of an orange brings to mind all its other attributes. III. *Representative* Cognitions, including all acts of recollection. IV. *Re-representative* Cognitions, including the higher abstractions formed by the assistance of symbols, as in Mathematics.

I can have little doubt that when Mr Spencer expounds this classification in detail, he will do much to elucidate the workings of the intellect. But, with the fullest deference to his philosophical acuteness, I consider that it proceeds from a mistaken point of view. In the science of mind we have to deal not with cognitions, things cognized, or the products of cognition, but with the *cognitive powers*, with the forces, functions, or attributes of mind called intellectual. A classification of our cognitions may throw light upon the cognitive powers; we must make use of them in illustration, but what we have mainly to deal with, is the process, or the means of arriving at those cognitions. The means are, as I believe, and as Mr Spencer would admit, the three primary powers of Difference, Agreement, and Retentiveness. Consequently, I consider that the unfolding of the mechanism of the intellect consists in the systematic exposition of these powers, and in the reference to them of all the popularly recognized faculties. I know of no other plan that has an equal likelihood of being comprehensive and exhaustive of the phenomena. Such a scheme as Mr Spencer's would answer certain partial ends; it would probably discuss once for all some important notions, such as Space and Time, whose derivation is, in this volume, broken up and scattered over different parts of the work. But, until actually shown by him to be capable of introducing, in a full and systematic way, all that I consider essential to an exposition of the Intellect, I am disposed to doubt its adequacy for this end.

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