ANOSMIA;

OR,

CASES ILLUSTRATING THE PHYSIOLOGY AND PATHOLOGY

OF THE

SENSE OF SMELL.

BY

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Received January 11th.—Read January 25th, 1870.

I WISH to bring before the Society some cases in which the sense of smell was either entirely lost, or greatly impaired. This I do not merely because such cases are comparatively rare; but because I think they may perhaps throw some light on the physiology of a sense which has been less studied than any other.

I will begin with three cases which have fallen under my notice in which smell, and smell alone, was completely lost.

CASE 1.—Mr. B. fell from a horse twenty-seven years ago, and struck his head heavily against the ground, on the left [illegible] and in the posterior part. Ever since the accident he [illegible] liable to headache, and his "nerves are not so

strong as they were." He has also ever since completely lost the sense of smell. The very strongest odours brought under his nose produce no sensation whatsoever. The tactile sensibility of his nostrils is with this quite unaffected. The slightest touch of the mucous membrane is felt perfectly, and snuff produces tickling and sneezing. He states that he has lost not only the sense of smell, but also that of taste: for he cannot in the least distinguish one meat from another. Boiled onions, boiled apples, boiled turnips, all appear the same to his palate. He cannot at all recognise the aroma or flavour of wines; though he can distinguish wines from each other to a certain extent by their different degrees of roughness and of sweetness. Port, for instance, he can tell from claret by its being sweeter and less rough. Besides sweetness he can distinctly recognise saltness, bitterness, acidity. Excluding these qualities, one substance is exactly like another to his palate, excepting so far as they are more or less hard and rough.

Notwithstanding all this he is not absolutely indifferent as to his food. He has preferences, derived apparently from memory;[1] and he especially dislikes any new article of diet.

There is no muscular palsy, no loss of sensibility, nor other symptom than those mentioned.

Case 2.—Mr. —— was knocked down by a cab some two years ago, and fell backwards, striking his occiput heavily against the road. For a minute he was stunned, but recovered, and managed to get home, where he was laid up for a time suffering from the local injuries, and from severe headache. All this, however, passed off, and he was left with no other permanent symptom than total loss of smell. This has remained without change ever since the accident. He cannot perceive the very strongest odours, that for instance of assafœtida. The tactile sensibility of the

[1] "*Ce sens*," says Longet, speaking of combined smell and taste, "*manque de mémoire*." The impressions of flavour would, however, appear from the above to be more permanently retained in the mind than Longet would admit.

nostrils is perfectly normal. Ammonia salts and snuff tickle his nostrils, and cause lachrymation or sneezing as in other men. He states that he has lost not only smell but taste. Cinnamon appears to his palate utterly without flavour. He cannot tell one meat from another when his eyes are shut, though he can in some degree distinguish various articles of diet by their tactile qualities. He cannot recognise the aroma of wine. Port, he says, tastes like sugar, claret like weak vinegar. The former also seems thicker than the latter. He can not only recognise sweetness and acidity, but also bitterness and saltness. This, however, is the limit of his gustatory perceptions.

He is not quite indifferent as to his food, but still has fancies and preferences, dependent perhaps on habit. So also he still smokes.

Case 3.—C. L— was admitted into hospital in February, 1869. He had been knocked about the head in a drunken row the preceding Christmas, and ever since had suffered from strange sensations in the head, and from occasional attacks of nose-bleeding. He was somewhat deaf since the injury to his head, and had completely lost his sense of smell. He could neither smell assafœtida nor buchu. He stated that he had also lost his taste; but he could perfectly distinguish quinine, table salt, and sugar, from each other, and pronounced each correctly to be bitter, salt, or sweet. After a short stay in the hospital, serious head symptoms declared themselves, and the man became so noisy and violent that he had to be removed; and eventually he became, I was informed, insane.

In all these three cases it is manifest that the sense of smell was entirely lost, and the first question is, How was this brought about? There can, I think, be little doubt that the loss was due to rupture of the olfactory nerves, as they pass from the bulb through the holes in the ethmoid bone. In the last of the cases the repeated nose-bleeding points to some injury done to this part of the skull. The deafness which accompanied the anosmia, and the subsequent violent head

symptoms, render it not improbable that the base of the skull had in this case been fractured.

In the other two cases it will have been noticed that the blow which caused the anosmia was on the occiput. Now it is well known that a blow at the back of the skull is not nearly so likely to injure the part of the brain immediately underneath as it is to injure the anterior and inferior portion, where the olfactory nerves lie. And the reason for this, as Mr. Hilton has pointed out, is, that the anterior brain rests directly upon the bones of the skull, and is not separated from them as is the case elsewhere by the interposition of cerebro-spinal fluid.[1]

It is easy to understand how a blow, which is not sufficiently violent to do serious mischief to the anterior brain generally, may still suffice to tear the olfactory nerves, owing to their very small size, and, still more, owing to their excessive softness. In only one recorded case of loss of smell from a blow on the head, have I found mention of the exact part struck. There also, as in these cases, the blow was on the occiput.[2]

It will have been noticed that in each of these three cases the patient complained of having lost taste as well as smell. If we use "taste" in the popular sense, as including the perception of aroma or flavour, doubtless each had done so. But if we limit "taste," as physiologically we are bound to do, to those sensations, other than tactile, which are communicated by means of the gustatory and the glosso-pharyngeal nerves, then in each the taste was unimpaired. For there was no difficulty in recognising either acid, bitter, sweet, or saline. Pure taste is limited to the perception of these few qualities, and any additional perceptions, other

[1] Hilton, 'Lectures on Rest and Pain,' p. 25. "When the blow is received at the posterior part of the skull, the whole mass of the brain being driven forwards from the momentum given to it by the blow upon the bones of the skull, the under surface of the anterior part of the brain rubs over the depressed and elevated surfaces which constitute the anatomical features of the internal base of the skull."

[2] 'London Hospital Reports,' vol. i, p. 470. [Since this paper was read, another case of permanent anosmia from a blow on the head has come under my notice. Here, also, the occiput was the part struck.—July, 1870.]

than tactile, which food may give us, are derived not from taste but from the much wider sense of smell, and are due to irritation of the olfactory nerves. We are so accustomed to the combination of simultaneous gustatory and olfactory impressions, that we have come to look on the two as one, and in popular language have confused them together. But disease splits this compound sensation of flavour into its constituents, and leaves the olfactory or the gustatory element to stand by itself, according as the latter or the former set of nerves have been injured. So much larger a share of the compound is due to smell than to taste, that, when a man has lost the former, he thinks, as in these cases, that he has lost both; whereas, if smell remain and true taste alone be lost—as sometimes occurs—the patient is almost regardless of his changed condition.

Doubtless we see from time to time cases which seem to stand in contradiction with the view here taken of the nature of flavour. These are cases in which the sense of smell, as tested by the application of odoriferous substances to the nostrils, seems entirely lost, while, notwithstanding this, the perception of flavour remains in comparative integrity. It is the existence of such cases which has caused physiological writers, as a rule, to define so hazily the limits of pure taste. The cases are, however, not difficult to explain. It will invariably be found in them that the olfactory nerves and region are sound, and that there is a free access for odours to this latter through the posterior nares, while some hindrance or other prevents the odours reaching it from the anterior nostrils. In other words the sense of smell in these cases is not lost; but defects in the accessory mechanism prevent its being exercised in one of the usual ways, while they do not prevent its being exercised in another. One or two of such cases which I have observed I shall now consider.

Case 4.—J. H— came under my observation in 1867, suffering from double facial
left side, and almost comple
the usual well-known sym

smell, and I found that with the left nostril he could hardly smell the strongest odours, while with the right nostril he could smell somewhat better, but still very imperfectly. Notwithstanding this he retained not only the sense of true taste, but also the power of perceiving flavours. He could tell one meat from another, distinguish aromatic substances, and so forth.

In every well-marked case of facial palsy, a similar anosmia may be observed, if trial be made of the nostril on the affected side. This fact is noted in most of our physiological text-books, but in none can I find any clear explanation of the cause of the anosmia. It becomes necessary, therefore, to consider the mechanism of voluntary olfaction.

There are two modes in which we purposely smell at a substance. In the one we close the mouth and then take a long deep inspiration through the nostrils. During the inspiration the nostrils are widely dilated, so as to give as free an entrance as possible to the air current. This, charged with odour, sweeps over the whole internal surface of the nose, the olfactory region included, and excites a sensation proportionate to its own velocity.

The second method is not quite so simple but much more efficacious. Here, as before, we close the mouth, but, instead of then taking one long deep nasal inspiration, we draw in the air by a rapid succession of short, shallow, but forcible "sniffs." If the nostrils be watched during this process, it will be seen that, so far from dilating as before, they actually contract at each "sniff." And a little attention will show that the contraction does not include the whole anterior opening, but only its posterior portion. At the same moment the cartilaginous sides of the nose may be seen to undergo lateral compression, by the action of the compressor naris muscle; and by this compression, which is most strongly marked in the part answering to the small sesamoid cartilages, the sides are brought slightly nearer to each other, and of course also to the central septum.

Now inside the nose the mucous membrane which covers the middle turbinated bone is prolonged anteriorly in an

elevation, called by Meyer[1] the agger nasi, which curves round and runs in a direction nearly parallel to the edge of the nose, till it reaches a point very near the anterior nasal orifice. By this agger and the middle turbinated bone the nasal cavity is divided into two parts, an upper or anterior one—the olfactory channel—and a lower or posterior, and larger one—the respiratory channel. The agger, which forms in part the boundary, approaches very near to the central septum, and the narrow chink which separates it is rendered still narrower by the great thickness of the septum in the part opposite to it. There is, indeed, according to Meyer, a kind of prominence on the septum answering to the prominence of the agger. A very slight lateral compression, therefore, of the nose would bring agger and septum into actual contact, and cut off the olfactory channel above from the respiratory channel below. This lateral compression is, as we have seen, brought about at each "sniff" by the contraction of the compressor naris. Were this all, the air-current at each sniffing inspiration would merely be divided into two parts, one of which would traverse the olfactory, the other the respiratory channel; but, at the same time as the two channels are separated, the anterior opening into the lower or respiratory one is closed, or at any rate greatly contracted by the lateral compression, which, we have seen, attains its maximum over the sesamoid cartilages, that is, just at the entrance into this channel.

It may, perhaps, seem doubtful whether the lateral compression is sufficient to bring the outer wall and septum, in this part, into actual contact, seeing how widely apart, speaking comparatively, they here are. So far as I can judge from my own sensations the contact does take place. It must, moreover, be remembered that, after all, the interval is an excessively narrow one, owing to the great thickness of the mucous membrane. And, secondly, I would point out that exactly across the entrance into the respiratory channel runs a line in which the external cartilaginous wall of the nose is broken, and replaced by yielding fibrous tissue. This line of

[1] 'Lehrbuch d. Anat.,' p. 620.

breakage runs between the upper lateral and the lower lateral cartilages, and is continued by the sesamoid cartilages round the back of the ala. It corresponds, that is, very closely with the direction of the compressor naris muscle, which covers it. When, therefore, this muscle contracts, it is plain that its pressure, acting of course with greatest effect where the resistance is least, will bend the external wall of the nose inwards, along the line in question, and bring it into more or less complete contact with the close-lying septum. By this contact the entrance into the respiratory channel will be closed, and the inspired air compelled to pass by the narrow but deep groove which leads to the olfactory region.

There is thus a useful purpose to be found in the otherwise unmeaning anatomical fact that the external wall of the nose is formed by the union of several pieces of cartilage, and not by one single expansion.

If the explanation I have offered be correct, it is plain how facial palsy must interfere with voluntary olfaction. With the first method it interferes by preventing active dilatation of the nostrils; with the second, by preventing the lateral compression which is required to close the respiratory channel. At the same time it will not materially interfere with the perception of flavours, for there is no hindrance to the passage of odours from the mouth upwards through the posterior nares.

Besides these cases of facial palsy, there is yet another class of cases, by no means uncommon, in which the perception of flavour remains, while the perception of odours by the anterior nostrils is lost. Of this class the following is an example.

Case 5.—Mrs. H— enjoyed, until some few years ago, the same powers of smell and taste as do other persons. She then suffered from a violent cold or influenza, which left her with chronic inflammation of the nasal mucous membrane. This, however, has long subsided, leaving her in the following condition. She cannot inspire air through the nostrils with the same ease and fullness as can others, and feels as though

there were some obstruction when she tries to do so. Exspiration, however, through the nose is much freer, and is not attended by any similar feeling of obstruction. The voice is somewhat nasal in tone. The most strongly smelling substances may be placed under her nostrils, while she inspires through the nose, without her perceiving in the least degree their smell. This I tested several times with such drugs as assafœtida and valerianate of iron. The tactile sensibility of the nostrils is normal; and she uses smelling salts and is affected by them as other folk. Notwithstanding this apparently complete anosmia, her perception of flavours remains almost in its integrity. She can tell one meat from another, distinguish various wines, and so forth without difficulty; though she admits that she does not think her palate is as accurate as that of most other people, or as was her own before the influenza.

Here then, again, we have an apparent contradiction to the statement that flavour is chiefly derived from smell. It is, however, not difficult to find an explanation. We have only to suppose, what is in itself highly probable, that the Schneiderian membrane has been so thickened by chronic inflammation as to bring the septum into contact with the middle turbinated bone and its prolongation, the agger nasi, a result which, we have already seen, would require only an excessively slight thickening of the membrane; and, secondly, that this thickening has not only thus cut off the olfactory from the respiratory channel, but that it has also obstructed the former and narrower of these two, the obstruction being of such a kind as entirely to prevent the passage of air inwards, while it allows of the passage of air outwards. We must suppose, that is, that the projecting fold of membrane acts as a valve. That this was the case is rendered almost certain by the fact that the exspiration through the nose was much freer than was the inspiration.

Supposing, then, that this very probable anatomical lesion has been left as the result of the chronic coryza, the apparent contradiction will be fully explained. The power of smelling through the anterior nostrils is gone, because there is no

access through these to the olfactory region. The perception of flavours remains because there is a free passage to this region from the mouth through the posterior nares.

Such cases, then, as these are not incompatible with the opinion that flavour is almost entirely due to smell. On the other hand, such cases as those given at the beginning of this paper are incompatible with any other opinion, if it be admitted (as I think it must) that the only damage done was to the olfactory nerves, and did not include the gustatory or the glossopharyngeal.

Incompatible also with any other opinion are those cases which occasionally occur in which the soft palate adheres to the posterior wall of the pharynx, so as to cut off all communication between mouth and nasal cavities. When this happens not only is the power of smelling through the nostrils gone, but with it is lost also the perception of flavours in the mouth, though both nerves of taste and nerves of smell are in their integrity. When the communication is established, either spontaneously or by the surgeon's knife, the perception of flavours and of odours is at once restored. The following example of this state of things I have recently had the opportunity of examining through the kindness of Mr. Gascoyen, whose patient the man is.

Case 6.—E. C— has suffered for some three years from adhesion of the posterior pillars of the fauces to the back of the pharynx. Two years ago this adhesion was so extensive that it was barely possible to pass an ordinarily sized director upwards between the wall of the pharynx and the central portion of the soft palate. Nasal respiration was impossible, to the man's very great inconvenience, who was unable to blow his nose, was utterly without smell, and had lost all perception of flavours. So great was his discomfort, that he was urgent to have an operation performed for his relief; but this was not then thought advisable. He has since improved much, and his present condition is as follows. The posterior pillars are still adherent to the back of the pharynx, but it is now possible to pass the tip of the little finger upwards

underneath the central palate which is not adherent to the pharyngeal wall. This passage upwards is, however, under ordinary circumstances closed, for the free portion of the soft palate is kept pressed back and in contact with the wall of the pharynx by the adhesion of the pillar on either side. While this is the case the man is completely unable to smell or to distinguish flavours, though he can still perfectly recognise true tastes, viz. sweet, salt, acid, bitter. This is his usual condition. But by an effort he is able momentarily to open the passage behind the velum, and when he does this he can for the time both smell and recognise flavours. On looking into his throat one can see that, during this effort, the free central part of the velum is pulled forwards away from the posterior wall of the pharynx, by the agency, I presume, of the palatoglossal muscles.

A case very similar in its general features to the above, was published some years back in the 'Lancet,'[1] by Mr. W. Coulson. There also the soft palate was adherent to the pharyngeal wall, and smell, together with the perception of flavours,[2] was suspended. No sooner, however, had an opening been made through the soft palate, than these lost faculties were restored.

I have now given cases in which the anosmia depended on injury to the olfactory nerves, and others in which the accessory organs of the sense were in fault. I pass on to cases in which the lesion was central.

Case 7.—E. D— was admitted into St. George's Hospital with right hemiplegia. He was also suffering from partial aphasia and agraphia. He complained of loss of smell. I tested the sense by bringing strong-smelling drugs to his

[1] 'Lancet,' 1862, p. 529.

[2] The patient in this case is said to have lost not only perception of flavours but also of some true tastes, such as of sugar, and of salt. It does not, however, appear that this was actually tested by Mr. Coulson, and it can hardly be supposed to be anything but a mistake. How could the adhesion possibly prevent the man from tasting salt, seeing that this can be distinctly tasted if applied to the tip of the protruded tongue, while the mouth is kept closed, and the nostrils compressed with the fingers?

nostrils, and it appeared that he was almost, though not quite, insensible to them. The tickling of ammonia salts, however, affected him normally. This man eventually recovered almost completely from his palsy and his aphasia, and at the same time his sense of smell returned also.

Case 8.—A. F— is at present under my care. After suffering for some time from acute pain in the left frontal region, he had a fit which left him with aphasia and agraphia, both of the amnemonic form.[1]

The aphasia is not so complete as to prevent him from making himself understood. There is no paralysis. He can smell much better with his right nostril than with his left one. When the right one is plugged and asafœtida placed under the other, sometimes he says he cannot smell it at all, at other times that he thinks he can smell something pleasant, but is not quite sure. The tactile sensibility of the nostril is normal.

Case 9.—E. L—, æt. 12, is now under my care. A month or so ago he suddenly lost power in his right side, and fell down without losing consciousness. A few hours later he had a fit, which left him with partial aphasia and incomplete hemiplegia of the right side. He has entirely lost smell in the left nostril. He cannot on this side perceive either peppermint, or assafœtida. The other nostril is of normal sensibility. There is no murmur with the heart-sounds.

I have seen other very similar cases. These, however, are sufficient for my purpose. Moreover, I am not the first to call attention to the frequent coincidence of anosmia with aphasia. A very interesting case of the kind was published in 1864,[2] by Dr. Fletcher and Mr. Ransome; and since then Dr. Jackson[3] has recorded three other examples of such coincidence. There can then be no doubt that aphasia and

[1] Cf. "Aphasia and Agraphia," a paper contributed by me to 'St. George's Hospital Reports,' vol. ii, p. 99, 1867.

[2] 'Brit. Med. Journ.' April, 1861.

[3] 'Lond. Hosp. Reports,' vol. i, p. 410.

anosmia are frequently combined, and it is not impossible that our knowledge of the pathology of the former may help to explain the latter. Now it will, I suppose, be admitted, even by the most determined opponents of cerebral localisation, that, at any rate, in a great majority of cases of aphasia, a brain lesion exists in close proximity to the fissure of Sylvius. To the floor of this same fissure can be traced the so-called external root of the olfactory bulb, finding, according to some anatomists, its ultimate termination in the island of Reil. It is, therefore, highly probable that the loss of smell in cases of aphasia results from the brain lesion extending into the fissure of Sylvius, and implicating the fibres of this root or their central termination. If this be the explanation, as can, I think, scarcely be doubted, the presence or absence of anosmia in cases of aphasia will for the future be perhaps of some use in enabling us to fix with greater precision the site and extent of the brain lesion.

In these cases it will be noticed that the loss of smell is only partial. It is confined to one nostril, this being, as anatomy would lead us to expect, on the same side as the brain lesion. But, even in the affected nostril, smell is not usually completely lost but only much impaired. At first one would be inclined to explain this by supposing that those parts of the cerebrum with which the middle and internal roots of the olfactory bulb are connected also take some share in the perception of olfactory impressions. But, seeing that sometimes the loss of smell is complete, as in Case 9, this explanation can hardly hold good;[1] unless, indeed, we are prepared to assert in such cases the existence of multiple lesions affecting all the various olfactory roots. The more probable explanation therefore is, that the external root is the only one of the three which is directly concerned in olfaction, and that it depends upon the degree in which this root or its central termination has been disorganised, whether the loss of smell be complete or partial. This view

[1] Another case of right hemiplegia, accompanied by aphasia, with the most complete anosmia of the left nostril, the right remaining normal, has come under my care since this paper was read.—September, 1870.

derives additional likelihood from the observation made many years ago by M. Serres,[1] that lesion of the external root is much more efficacious in determining anosmia than is lesion of the internal root. Nineteen post-mortem examinations of paralytic patients confirmed, he says, this result.

The cases I have as yet brought forward have all fallen under my own observation. I beg leave now to call attention to a case which was recorded many years ago in the 'American Journal of Medical Science.'[2] This case seems to have been passed over as a mere medical curiosity, but I think I shall be able to show that it possesses very considerable physiological interest.

A boy in Kentucky, son of two black slaves, had up to his twelfth year a skin of the same dark colour as that of his parents. At this period a white patch appeared near the inner canthus of the left eye. This white patch spread gradually, until in ten years' time it extended over the whole external surface of the body: so that, but for his woolly hair, the boy might have been taken for a very fair European. Later on, some few brownish or copper-coloured spots appeared on the face and hands; but the parts which were not exposed retained permanently their perfect whiteness. At the same time that the boy began to change his colour, he began also to lose the sense of smell, and by the time he had become white his smell was so seriously impaired that Dr. Hutchison, who records the case, states it to have been completely lost. There are, however, in the published account some observations which seem to render it rather doubtful whether this was the case.[3] At any rate smell, if not entirely lost, was very greatly impaired.

Dr. Hutchison does not appear to have supposed that

[1] Chez les malades que j'ai observés, l'alteration matérielle de la racine externe a paralysé l'olfaction d'une manière beaucoup plus prononcée que de l'interne. Dix-neuf ouvertures de sujets ayant succombés à des paralysies ont confirmé ces résultats." 'Anat. comp. du cerveau,' i, 295.

[2] See op. cit., 1852.

[3] My reason for doubting is this. The boy is said to have retained his taste completely. Now, Dr. Hutchison seems to use the word "taste" in the popular sense, as including the perception of flavour. If the boy

there was any connection, save of coincidence, between the loss of colour and the loss of smell. It is, however, I think, almost impossible to suppose that the simultaneous occurrence in the boy of two such extraordinary phenomena can have been merely fortuitous. At the same time it is not manifest at first sight how the two symptoms were bound together. The connecting link is, I venture to suggest, to be found in the fact that the mucous membrane of the olfactory region is, like the rete mucosum of the skin, rich in pigment; and it is not unreasonable to suppose that the mysterious disease which destroyed the pigment in the one tissue may also have destroyed it in the other. Physiologists have entirely passed over the constant occurrence of pigment in the olfactory region, regarding it apparently as a matter of no possible interest or importance. I cannot, however, but think that in this they are mistaken, and that there are good grounds for supposing that the presence of pigment, if not actually necessary for olfaction, at any rate conduces much to its keenness and perfection. The grounds on which I base this opinion, I shall now proceed to examine.

In the first place, then, it is a striking fact that not only in man but in all mammalia the epithelium of the olfactory region is pigmented, though that of the rest of the nostrils and of the sinuses is colourless. That is to say, pigmentation extends to all the region which is receptive of impressions of smell, and extends no further. One cannot but suppose that some useful purpose is implied by this persistence. Secondly, if we compare one species of animal with another, there appears to be some correspondence between the amount and intensity of this nasal pigmentation and the acuteness of

retained this he had not completely lost "smell." The tests, however, which Dr. Hutchison used, were not sufficient to decide whether the perception of flavour remained. He found, for instance, that the boy could tell bacon from turkey. This could be done by pure taste, for one is salt and not so the other. Butter could be distinguished from lard. This may, however, be explained by tactile differences; perhaps also by differences of saltness. Molasses again from honey. Here also there is a difference in sweetness, and also a tactile difference.

smell. I have been unable to obtain such perfect data on this point as I could wish; but this much at any rate I can state: that in the dog, the cat, the fox, among carnivora, the sheep and rabbit among herbivora—all animals in which this sense is highly acute—the pigmentation extends over a larger space, and is of a darker tint than is the case in man, where the sense is comparatively rudimentary.[1] Again, not only does the olfactory region in man contain less pigment and lighter coloured pigment in its epithelium than is the case with more keenly smelling mammals, but it is also entirely or almost entirely without any of what are called Bowman's glands, which in the other animals are abundant.[2] But these glands of Bowman form a secretion, rich in molecules of yellow and brown pigment;[3] and this secretion keeps the olfactory region constantly covered with a layer of pigmented mucus.

Thirdly, a similar correspondence between extent of pigmentation and keenness of scent seems to exist when we compare one race of men with another. We may fairly assume that in the dark-skinned races there is, as a rule, more pigment in the olfactory region than is the case in races of lighter hue. For it is known that the excessive pigmentation of a negro is not confined to the skin, but extends internally to the iris and choroid, and even, as Meckel first pointed out,[4] to the tissue of the brain; an observation which was afterwards confirmed by Le Cat and others. Now it is a

[1] In man the olfactory pigment is of a lightish-yellow tint. In the cat it is of a deep yellow-brown, and extends over a relatively larger surface than in man (Ecker). In the fox the pigment is of the same colour as the hair, viz., a red-brown, and there are abundant glands of Bowman, secreting a pigmented fluid (Ecker). In the dog the pigment is brown or yellowish-brown. In the rabbit it is brown (Krause), sienna-brown (Todd). In two sheep I found it almost black; but the colour must be variable in sheep, for Kölliker found it yellowish.

[2] Cf. Fick. 'Anat. der Sinnesorgane,' p. 92. In man the place of Bowman's glands is occupied by ordinary mucus-glands. See also Ecker's plates.

[3] Cf. 'Frey's Histol.,' p. 666.

[4] Le Cat, 'Traité de la couleur de la peau humaine,' &c., 1765, p. 51. Le Cat's observation was "confirmed subsequently by Meckel and others,

striking fact that it is in these coloured races that the sense of smell acquires its greatest perfection. In most physiological text-books instances are given of acute smell: and these instances will be found invariably to be derived from coloured races of men. The Arabs of the Great Desert are said to be able to distinguish the smell of a fire thirty miles off. The North American Indian is said to be able to follow his enemy or his game, like a hound, by the scent. A like keenness belongs to the Indians of Peru, according to Humboldt. The African negro can distinguish the traces of a white man from those of a black. Lastly, of all the inhabitants of Asia it is the black Kalmuck who is described as possessing the most extraordinary delicacy of olfaction.[1] These facts are the more trustworthy, that their various reporters had no thought of any connection between the colour of the skin and the keenness of scent, but explained this latter either as the effect of long-continued practice, or as the result of patulous nostrils.[2]

A similar correspondence between the degree of nasal pigmentation and the keenness of smell may, I think, be detected even in white individuals, by comparing one period of life with another. The olfactory sense is apparently but feeble in youth; children being notoriously dull in perception of flavours, which, as already said, are chiefly derived from smell; whereas their perceptions of true tastes are as keen as those of adults, sweets attracting them, and bitters, salts, or acids being, as a rule, repugnant to their palates. Now, in all young animals the nasal pigmentation is much less

negroes, found no such cerebral pigmentation. Cf. '*Ueber die Körperliche Verschiedenheit des Negers,' &c.*, 1785. It is therefore probably not a constant phenomenon. So also Le Cat found more pigment in the brain of black rabbits than in that of white ones (op. cit., p. 55), but not invariably (p. 57).

[1] Single examples are not worth much. Still it is interesting to note that Mohammed, the only historical personage, so far as I know, who was renowned for the excessive sensitiveness of his smell, was also remarkable for the deep blackness of his eyes and of his hair. His head "even in advanced age was sprinkled by only about twenty grey hairs." See 'Quart. Review,' October, 1869, p. 303.

[2] 'Haller El. Phys.,' t. v, 179. 'Longet, Phys.,' iii, 51. 'Carpenter's Phys.,' 7th edition, p. 686.

intense than is the case in adults.[1] So that, here again, the olfactory incompetence may not unreasonably be attributed to the deficiency of pigment.

It may, however, be objected that, if the view I have now advanced were true, all albino animals—man and mammals alike—should be destitute of smell, or, at any rate, very deficient in this respect. Were *all* pigment absent from the body this very possibly might be the case, and the history of the negro boy which I have given supports this opinion. But I would point out that an entire absence of pigment, if it ever happens, is at any rate an excessively rare occurrence. Even in the whitest-skinned animals there is, as a rule, if not always, some pigment; and it is a notable fact that the last place which the pigment deserts is the skin of the face, and especially the skin about the nose and ears. Now, the internal nasal and aural cavities are formed by an involution of this outer skin; and we may, therefore, not unreasonably assume that the persistence of pigment in these portions of the skin is a probable indication of persistence of pigment in the involuted organs. And this assumption is borne out by the observed fact that such a connection does in reality exist between the pigment of the eye and that of the neighbouring skin. For it has been stated by Geoffroy St. Hilaire[2] that in what are called "pied" negroes—that is, in negroes whose skin has become white in patches—the eyes are ordinarily without pigment if the skin of the ocular region be white; and, on the other hand, that if the skin of this part retain its ordinary tint, so also do the eyes. This persistence, then, of pigment about those parts of the skin from which the nasal cavities are developed supplies a fifth argument in favour of the view I am advocating. Examples of such persistence are endless. I may recall the well-known instances of black-faced sheep and black-faced cattle. Neither of these are, however, what is called albino; for in both abundant pigment is present in the eyes. A more complete illustration is furnished by certain rabbits. In the variety known as Himalayan not

[1] Cf. 'Frey's Histol.,' s. 664.

[2] 'Hist. des Anomalies,' &c., t. i, 309.

only is the skin and fur of the most snowy white, but the eyes are of the brightest pink. Yet even in these albinos there are invariably patches of dark colour on the nose and ears. Knowing, as we do, how important a part is played by pigment in vision, we should have expected that the eye would have been the last part to surrender its colouring matter; whereas, we find that, though very persistent there, the pigment is still more persistent in nose and ears.

We can understand, then, why albino animals should not necessarily be destitute of smell, even though pigment be required for the due exertion of this sense. Still we should expect that, on the whole, this sense would incline to be less acute in white animals than in those of darker hue. Now, that this is really the case is, I think, rendered highly probable by the following considerations. Feral animals are, it is universally admitted, guided in their choice of food by the sense of smell. It is by the keenness of this sense that herbivora are enabled to avoid poisonous plants and to select nutritious ones. We all know how a horse tests the oats set before it with its nose, and not with its eye. It is plain, then, what an important part the sense of smell plays in the lives of these animals, and what fatal results might occur to them were its exquisite delicacy at all diminished. Their power of discriminating between the wholesome and the unwholesome would be lost, and they would fall victims to the first poisonous plant that chance might throw in their way. Now, it is not very uncommon for such an accidental poisoning to occur; and it is in striking harmony with my hypothesis, that in the vast majority of such cases the poisoned animal is a white one; that is, an animal whose sense of smell would be likely, according to my view, to be somewhat obtuse. The facts which I shall cite in support of this statement I take partly from a paper written many years back by Prof. Heusinger,[1] partly from the rich storehouse of Mr. Darwin's works.[2] In some parts of Virginia the farmer will only rear black pigs because the white ones eat and are

[1] See Schmidt's 'Jahrbücher,' 1847, p. 281.

[2] 'Animals and Plants under Domestication,' ii, 335.

poisoned by the roots of the Lachanthes tinctoria. Professor Wyman, who was struck by the absence of white pigs from the district, was told by one of the squatters that "we select the black members of the litter for raising, as they alone have a good chance of living." In the Tarentino, again, the inhabitants only rear black sheep, because the white ones eat and are poisoned by the abundant Hypericum crispum of that region. So accounts are given of white horses eating poisonous food, while the coloured horses escape. White rhinoceroses are said to perish from eating the Euphorbia candelabrum; not so the black.

I am indeed aware that Mr. Darwin and other writers have given a different account of this matter. They suppose that both coloured and white animals alike eat the poisonous food; but that, owing to some hidden constitutional peculiarity correlated with their colour, the white animals are poisoned by a plant which is innocuous to the black or coloured.[1] I cannot, however, find out that there is any positive evidence that the coloured or black animals really *do* eat the plants in question. Nowhere can I find the statement of an eye-witness of such an occurrence. I suspect, therefore, that it has been merely an assumption that they do so, it having not unnaturally been taken for granted without strict inquiry that what one horse or sheep will eat another horse or sheep will eat also. In the absence of clear proof to the contrary I cannot but think it more likely that the white animals suffer because they eat the poisonous plants, while the black animals escape because they avoid them; and I think I have shown fair grounds for suspecting that the explanation of this difference of habits is to be found in differences of acuteness of smell, depending on the presence or absence of abundant pigment in the olfactory region.

[1] That a relation exists between the colour of animals and their susceptibility to poisons is an opinion as old as Aristotle, who says ('Hist. Anim.,' viii, 28) that the bite of a scorpion is much more dangerous to a black sow than to a white one: "*καὶ τὰς ὗς, αἱ ἥκιστα αἰσθάνονται τῶν ἄλλων δηγμάτων, καὶ τούτων τὰς μελαίνας μᾶλλον ἀποκτείνουσι.*"

What an advantage in the struggle for existence a keenly smelling animal must have over one of more obtuse sense is manifest.[1] If it be carnivorous it will detect its prey the sooner, and follow it the more surely. If it be herbivorous it will avoid poisonous food with greater precision, and will, moreover, have earlier notice of the approach of a foe, and so more time for escape. It is not, therefore, surprising that, with animals living in their natural condition, whiteness should scarcely exist except as a monstrosity, all wild breeds being more or less coloured;[2] nor that attempts to stock woods with white rabbits should have failed, the white variety being supplanted in a very short time by coloured ones.[3]

Another argument in favour of my hypothesis is, I think, to be drawn from those albino rabbits to which I have already

[1] Doubtless there are other causes besides obtuseness of smell which render whiteness disadvantageous to wild animals. They are, for instance, as Mr. Darwin and Mr. Wallace have pointed out, much more conspicuous to their foes. Besides, they suffer much more from exposure to strong sunlight than do coloured ones. A white man if so exposed—and especially if parts usually covered, and so whiter, are exposed—is soon blistered. A black man suffers no inconvenience. There is the same difference in the effects on white and on black animals. The white suffer; the black escape. If an animal be partly white, partly coloured, then excessive sunshine often causes inflammation and loss of hair on the white parts, while the black parts are uninjured. There are many such cases on record. These ill effects seem not to be due, as is usually supposed, to the heat, but to the light. For, in the first place, black is no protection against heat, but the contrary. Secondly, prolonged exposure to much greater heat than that of bright sunshine, for instance, to that of a Turkish bath, does not blister one's skin. Thirdly, prolonged exposure to strong light, without intense heat, *does* blister the skin, as all know who have walked much in the glaring snow regions of the Alps. The use of the black skin to men and animals seems to consist in the black absorbing the rays of light, and converting them into heat.

[2] I am not a sufficient adept in natural history to say how many wild breeds of mammals are white. The following are such as occur to me. The white polar bear: but in this animal the muzzle, the tongue, the eyelids, the mouth, are black. The white cattle of Chillingham have black muzzles and black eyes. The white oryx has dark patches about head and nostrils. The white arctic fox has, even in summer, jet black nostrils. The white whales of Spitzbergen appear to have no coloured parts, but they are also supposed to have no sense of smell, or very obtuse smell.

[3] Cf. Darwin, op. cit., ii, 230.

referred. These are born perfectly white, and remain so for several months, in fact, until they are weaned. It is then only that the patches of colour appear about the nose and ears. Now, if the presence of pigment be, as I suppose, intimately connected with acuteness of smell, this development of pigment when the animal is first left to its own resources becomes intelligible. For it is plain that while the suckling lives at the expense of its mother it has no need for keen scent, but that so soon as it has to shift for itself and select its own appropriate food, this sense, as we have already seen, becomes of paramount importance.

The probability of this explanation is very much increased by what we know of such other changes as occur in the young animal at this period. For these all have the most unmistakeably direct reference to the new diet on which the weaned animal is henceforth to feed. Such a change is the development of teeth, now first required for mastication. Such, also, is the alteration which now occurs in the salivary secretion. So long as the animal is sucking, its saliva is incapable of converting starch,[1] none of which is present in milk; but the secretion acquires this faculty about the time when the animal is weaned, and begins to live on a diet in which starch is an important ingredient (Schiff). Such, also, is the change which about this period occurs in the gastric juice. This in the suckling acts energetically by means of its pepsine upon milk, which it coagulates; but the pepsine of the weaned animal is entirely destitute of this power (Wasmann). Thus the absence of pigment from the Himalayan rabbits in the first months of their existence, and its development at the period of weaning, is, by my hypothesis, brought into the most complete harmony with the

[1] There is one exception to this general statement. The saliva of the newborn guinea-pig converts starch (Schiff, 'Digestion,' i, 206). But the apparent exception is really a confirmation. For this animal is born in a much more advanced condition than other mammals. It can run about and pick up food for itself almost as soon as it is born. It is from the first independent of its mother's warmth (Carpenter, 7th ed., p. 495); and it succumbs to asphyxia as rapidly as do adults, being destitute of the power of resistance which belongs to other young mammalia (B. Séquard's 'Journ. de Phys.,' ii, 93). Indeed, it is not born until it has already shed certain deciduous teeth (Cuvier).

other structural changes which occur at this period of the animal's life.

It may perhaps appear to some that this question is one which could be easily solved by simple experiments; that we have only to take white and coloured animals of the same species, and directly test their relative acuteness of olfaction. But a very little consideration will show that such a method would in this matter be perfectly impracticable. Were it indeed a question of entire absence of smell, then we might hope for a solution, though physiologists have found it difficult enough to decide even as to total anosmia in animals. But when the question is not of total loss of smell but merely of degrees of acuteness, what was a difficulty becomes an impossibility. Let any one try to classify some dozen men by their differences in this respect. He will find it almost impossible. Yet we may suppose that by applying aromatic substances to the nostrils or palate of each in succession, and carefully noting the account each gave of his sensations, we might, in time, arrive at some rough conclusion. But, clearly, if the men were all deaf and dumb and unable to give any account whatsoever of their sensations, even this imperfect result would be unattainable. We possess then no gauge by which to test directly the acuteness of smell in dumb animals; and we must content ourselves with the less direct plan of observing how far they perform unerringly such actions as imply keen scent. One such action is the avoidance of poisonous plants, and I have already shown that there are reasons for suspecting that coloured animals do this with greater precision than do white ones.

We come now to the final question. Is there any conceivable mode in which we can imagine the olfactory pigment to affect the reception of olfactory impressions? In the eye we can partly understand how the pigment may act, but in the nose no obvious explanation is at hand. There are, however, some observed facts respecting odours, which, I think, may perhaps give us a clue. It has been noticed by several writers that dark substances absorb odours much more readily than do light ones. "Haller, of Vienna,"—I quote from Dr.

Murchison's book on Fevers, "observes that dark coloured materials of clothing are more prone to absorb the contagion of typhus and to convey it to other individuals than those which are light coloured. He found that among troops wearing dark coloured uniforms it more frequently happened that new cases of typhus entered the hospital after a convalescent patient had rejoined his corps, than among those wearing light or white uniforms. It may be mentioned that in dissecting-rooms dark clothes acquired the cadaveric odour sooner and were deprived of it less readily than light ones; and he ascertained by experiments that the absorption of odours is regulated by the laws which govern the absorption of light."[1] Experiments have also been made by Dr. Stark, of Edinburgh, in order to determine the differences in this respect of differently coloured substances. He found that black was the most powerful absorbent of odours; next in order came blue; then, successively, with decreasing intensity, green, red, yellow, and, last of all, white; in this absorption was reduced to the minimum.[2] Like experiments were afterwards made by A. Dumeril,[3] of Paris, and with practically like results.

Here, then, we have a possible explanation of the matter. The pigment which is so constant in the olfactory region is there to absorb the odorous emanations. The darker the tint of the pigment, and the wider its extension, the greater will the absorption be. Hence the keen scent of black or coloured animals and men. The lighter the pigment, or the smaller the surface over which it extends, the less on the other hand will be the absorption of odours. Hence the comparatively frequent poisonings of white animals. When the pigment is altogether absent, then absorption will be at its minimum. Hence the anosmia of the white negro whose case has led me to this discussion.

I have now nearly finished what I have to say of smell. I cannot, however, refrain from pointing out briefly that there

[1] Op. cit., p. 88.

[2] Longet's 'Physiol.,' iii, p. 36, 3rd ed.

[3] 'Des Odeurs, de leur Nature et de leur Action Physiologique.' Paris, 1848.

seem to me to exist some grounds for believing that pigment plays a part even in the reception of auditory impressions.

In the membranous labyrinth black pigment is found in varying amounts. As to the exact position of this pigment in man, and its relation to the ultimate nervous organs, nothing accurate has been ascertained. But in the labyrinth of certain fishes the arrangement has been made out, and it is of importance to note that the relation here of the pigment to the ultimate nerve organs is identically the same as exists in the olfactory region of higher animals; so that a diagram of the one organ will almost stand for a diagram of the other.[1] In each the ultimate nerve-organs consist of certain cellular prolongations, and in each interposed between these ultimate nerve-organs are pigmented epithelium cells.[2] This similarity of arrangement renders it highly probable that there is also some similarity of function. So that, if it be admitted that the pigment in the nose serves any purpose, it will be highly probable that the pigment in the labyrinth serves a like use. Secondly, we find among mammalia generally the same tendency to retention of pigment in the skin of the ears which I have already pointed out as existing about the nostrils; and the membranous labyrinth is developed by an involution of this external integument.[3] Thirdly, in some animals there does most certainly exist a strange connection between the amount of pigment in the body, and the sense of hearing. Sichel[4] pointed out, many years ago, and Mr. Darwin has since made the fact generally known, that cats with pure white skin

[1] The same diagram will also serve fairly to represent the termination of the nerves of taste in the frog's tongue. Here, also, accordiug to the researches of Axel Key, made under the direction of Max Schultze, the nerve-fibres are connected with certain terminal cells, resembling those of the olfactory region, and interposed between these terminal cells are epithelium cells containing yellow pigment granules. (Cf. Funke's 'Phys.,' ii, 82.)

[2] Cf. Fick, 'Sinnesorgane,' fig. 30.

[3] According to Huschke's discoveries, confirmed by Reissner and Remak. Cf. Kölliker's 'Manual of Micr. Anat.,' p. 600.

[4] 'Ann. des Sciences Nat.,' 3me Série, Zoologie, viii, 239.

and blue eyes are almost invariably deaf. Should the perfect white be marred by a single blotch of colour, then the deafness is absent. Or even should a kitten born without pigment, and therefore deaf, develop pigment at a later period, the deafness will cease. A white kitten was found by Sichel to be quite deaf. When it was four months old the iris began to assume a darker tint, and with the development of pigment came also the sense of hearing.[1] Lastly, abnormal pigmental constitution, as shown by the tendency to pigmental retinitis, is known to be frequently associated with partial or complete deafness. Dr. Laycock observed[2] five cases of such association in a single family, and out of 241 deaf mutes at Berlin Liebreich found no less than fourteen to be afflicted with this comparativcly rare pigmental disease.

All these various facts cohere into a consistent whole if we imagine that the pigment of the membranous labyrinth is a part of the mechanism of hearing, but, without such a supposition, admit, so far as can be seen, of no intelligible explanation. For to say that they are instances of correlation of growth is of course no explanation. It is merely to state in different terms the fact of the frequent combination in an individual of two peculiarities.

It would appear, then, not improbable that the organs of three main senses, sight, smell, hearing, require each, for the full performance of its function, the presence of pigment. One cannot, therefore, but be inclined to inquire whether they may not want it for some common purpose. In each of the organs the pigment is not contained within the nerve-structures themselves, but lies external to these and in immediate contiguity with their ultimate elements. Thus, in the eye it is in contact with the cones and rods of the retina; in the nose in contact with the olfactory cell-processes; in the aural ampullæ with similar cell-processes which form the terminal bodies of the auditory nerve. As in each case

[1] This observation appears to me to lend additional probability to the supposition advanced at pages 283–4 as to the appearance of pigment in Himalayan rabbits at the period of weaning.

[2] 'Med. Times and Gaz.,' 1866 and 1867.

the pigment is thus external to the nerve structures, its use is more probably connected with the reception than with the transmission of sensory impressions. Seeing that both in the eye and in the ear the sensory impression is known to result, not from the contact of material particles given off by the object seen or heard, but from waves or undulations of ether or of air, one cannot but suspect that the same may be true in the remaining sense, and that the undulatory theory of smell, deriving also, as it does, support from some other facts, may, perhaps, after all be the true one. This supposition would clearly be greatly strengthened could it be shown that pigment is in any way specially suited for the absorption or modification of undulations.

Now, it has been known since the days of Franklin that the absorption of waves of heat is greatly affected by the colour of the absorbing substance; and that differently coloured substances absorb the waves of light in different proportions, and, in fact, owe their different colour to this is, of course, a recognised fact, the wave of light thus absorbed being converted into undulations of heat. We have seen also that these coloured substances apparently behave towards odours much in the same way as they behave towards light. The corroboration, then, is not wanting.

Now, in the case of the eye, Professor Draper has argued, as it appears to me with good reason, that the image is not formed, as is usually said, upon the transparent retina, but on the screen of black pigment which lies behind. By this he believes the rays of light to be absorbed and converted into vibrations of heat, so that what was at first a light-picture is now, so to speak, a heat-picture, in which each different shade and colour is represented by a different degree of temperature. "In this local disturbance of temperature," in his opinion, "the act of vision commences, the club-shaped particles of Jacob's membrane being truly tactile organs which communicate to the sensory surface of the retina the condition of temperature of the black pigment."[1]

Doubtless, this view of Professor Draper's is not the

[1] Draper's 'Physiol.,' p. 392.

current one. Admitting it, however, to be true, one cannot but ask whether a similar function may not attach to the similarly placed pigment of the nose and ear—whether this also may not serve to absorb vibrations of odour and of sound, and to convert them into vibrations of heat, which will affect the contiguous cells, in which, as we have seen, the olfactory and auditory nerves find their termination.

This claims, of course, to be no more than a speculation, and even as such is open to one manifest objection. Physicists do not recognise the existence of any relation between the pigmentation of substances and their power of absorbing sound. To this, however, I would reply that physicists, to the best of my belief, have not yet experimented on the matter, and that it is not impossible that such a relation may exist, undiscovered, because unlooked for; just as a similar relation between pigmentation and the absorption of odours has lain for ages unsuspected and therefore unknown.

Be this, however, as it may, my object will have been attained if I shall have succeeded in calling the attention of physiologists to the constant presence of pigment in the terminal organs of hearing and of smell, and to the many reasons there are for believing that it plays there some part; perhaps, one not less important than has been long conceded to it in the organ of sight.