ANALOGY BETWEEN THE MOVEMENTS OF PLANTS AND THE MUSCULAR MOVEMENTS OF CHILDREN, CALLED CHOREA.

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If an analogy can increase knowledge, give more precise ideas, or guide observation, it is useful, and not a mere indulgence of the imagination. The analogy between plant movements and muscular movements appears to me to be legitimate. We will examine a few cases of the movements of plants, as demonstrated by Charles Darwin in his work on *The Movements of Plants* (1880). In the oxalis (wood-sorrel) tribe, and in the mimosa (sensitive plant), movements of leaves are seen. In each case, the movements are effected by an arrangement of cells at the junction of the leaf with its main stalk; this group of cells is called a *pulvinus*. The pulvinus is the mechanism by which move-

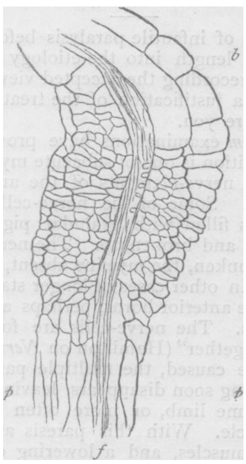

Fig. 1.—After Darwin. Longitudinal Section of a Pulvinus, magnified seventy-five times. *p p*, Petiole, or Leaf-Stalk; *f*, Fibro-vascular Bundle: *b b*, commencement of Blade of Cotyledon.

ment of the leaf is effected; it consists of a mass of small cells, destitute of chlorophyll, and therefore incapable of performing any nutritive function in the plant, or of taking any direct part in the elaboration of its nourishment. This pulvinus is the lower portion of the petiole or leaf-stalk; and the movements of the leaf depend upon its cells, which expand alternately, first on one side, then on the other. Structurally, the pulvinus consists of small cells arrested in their development while still young. These, when turgescent with sap, swell up, thus increasing suddenly the bulk of the structure composed of them; and this turgescence leads to motion only. It is not followed by growth; no nutrition of the plant results from the turgescence. It must be noted that the cells possessing this special function of producing motion only, fulfilling no direct nutritive purpose, are smaller than their neighbours, arrested in their growth, and destitute of chlorophyll. This is the condition of the cells of the pulvinus as long as it is capable of producing movement. In the *oxalis corniculata*, the pulvinus is developed imperfectly and to an extremely variable degree, so that it is apparently tending towards abortion. Its cells contain chlorophyll; that proves they have nutritive functions to perform, as well as the production of movement. These cells are more like the normal cells of the petiole than those usually characteristic of a pulvinus.

In the young seedling plant, the root and seedling leaves (cotyledons) are constantly moving (circumnutating); this movement being due to the order and method of growth of the cells of the part. In many cases, all parts of a plant are constantly moving; and, under special circumstances, this movement may be modified in one direction. Thus, with the sensitive plant, under the influence of light, a rapid movement of the leaf may occur in one direction; such movement being but a modification of the motion constantly occurring in a manner usually imperceptible. These facts are borrowed from Mr. Darwin's book, which is full of such illustrations.

Now, it seems to me, after carefully watching the conditions of spontaneous involuntary movement in children under different circumstances, that a very fair analogy may be made between these movements of plants and the choreic movements of children. If we assume that in the brain of a child there be certain nerve-cells in a condition analogous to the vegetable cells in the pulvinus, they would be smaller than healthy ones, lacking in full development, more liable to turgescence (active determination of blood or nutriment), such turgescence causing the liberation of motor force only, which is transmitted by the nerves to the muscles, the mechanism of movement. The turgescence leads to motion only, not to nutrition. We should, then, expect to see in the patient an excess of spontaneous irregular movement, nutrition being defective. Again, there might be supposed to exist in a child's brain cells analogous to those of the rudimentary cells of the pulvinus of *oxalis corniculata*, apparently passing over, in the stages of development, from the condition of cells above described, to acquire the power of receiving nutrition from turgescence, and thus produce growth and their own specific functions in place of motor power only. In such a case, the brain would become less mobile, less choreic, but more capable of its own proper functions.

Again, if we inquired as to the movements of the primary leaves (cotyledons) of seedling plants, we should see what a large amount of movement the young growing parts produce; how the movement is mostly due to the growth of cells alternately on each side of the leaf—that side on which growth is for the time occurring more rapidly becoming convex; then, as the seat of most rapid growth is transferred to the other side of the leaf, the side of convexity is reversed. Here, then, in the young rapidly growing cellular vegetable organism, without circulatory or nervous systems, spontaneous movement is constantly occurring, owing to that *unknown law which causes the cells to be specially nourished first in one part, then in another*. Many other analogies might easily be suggested between the known action of vegetable cells in causing movements, and the spontaneous involuntary movements produced by the nervous system, which we may observe in children and other young animals. The inference is, that there may be a true analogy between the conditions of life and development of vegetable cells producing movement, and the nerve-cells which produce movement in animals; and that, as in the plant, so in the animal, the arrest of development of cells may cause them to be liable, on stimulation, to produce motion in place of their proper functional effects; and that, in plants and animals, growing young cells often produce much motion.

In children, I have often observed that "the weak and nervous" have much spontaneous finger-twitching; and I described this as one of the physical signs seen in children who suffer from recurrent headaches and associated pathological conditions (British Medical Journal, Dec. 6th, 1879; see also *Brain*, 1881, parts XI, XII, XIV). Such muscular unsteadiness seems very analogous to the movement of young, growing, sensitive vegetables.

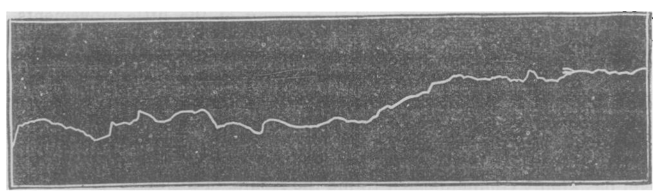

Fig. 2.—Tracing of Involuntary Movements of the Finger in a Nervous Child.

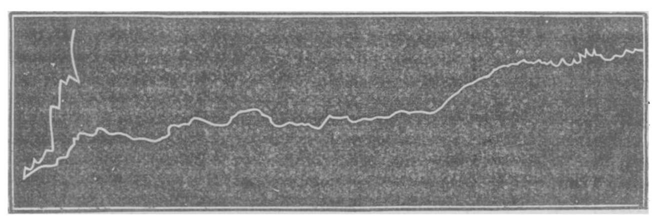

Fig. 3.—Tracing of Involuntary Movements of the Finger in a Nervous Child.

These two tracings indicate the continuous condition of spontaneous muscular unsteadiness of the finger of a nervous child; and the continuous involuntary movement appears analogous to that indicated by the tracing of the movements of some plants. Now, if this analogy between unstable mobile vegetable cells and unstable nerve-cells be legitimate, it should guide us to further useful observations.

To be brief, Darwin's observations show that movement produced by the growth of vegetable cells is constant in the leaves, stems, and roots of many young plants. If the movement of nervous children be produced by a condition of brain-cells analogous to that of the growing parts of plants or the cells of the pulvinus, it should be liable at times, under certain circumstances, to great exacerbations. Thus guided, I have taken tracings of the finger-movements of nervous children and of those suffering from chorea. Samples are presented here, and seem to indicate the following results.

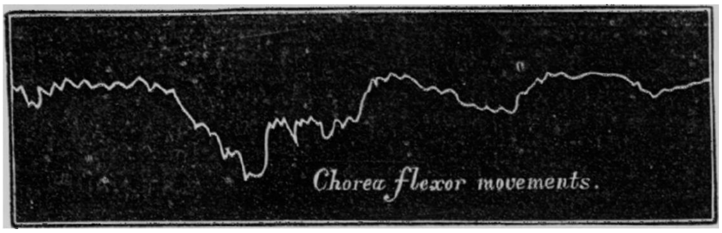

Fig. 4.—Tracing of Finger-Movements in Chorea.

1. The movements of chorea are far more frequent and continuous than might be expected from mere inspection of the hands.

2. These movements may be but an exaggeration of the movements of a nervous child, usually present, but often overlooked, tracings of which are given in Figs. 2 and 3.

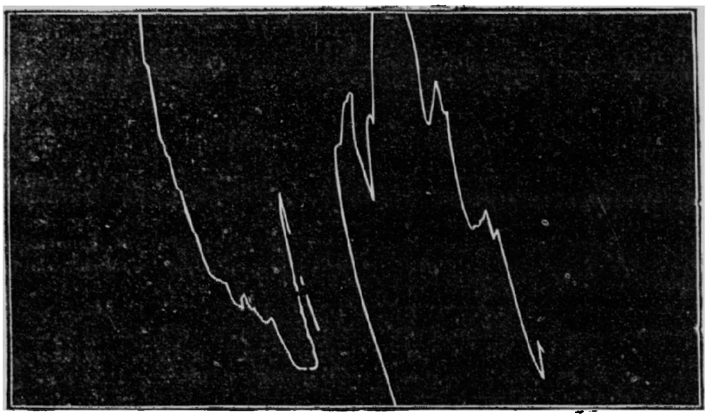

Fig. 5.—Finger-Tracings in Chorea. The twitching movements are compound.

3. The twitching movements of chorea may be compound, each visible twitching being compounded of many of the little movements seen in the other tracings. I have never found such compound tracings in tremors as paralysis agitans.

To prove these points with certainty, numerous tracings from many cases would have to be compared.

As to the treatment of the class of children referred to, the following experiments are very suggestive, and the analogy to the case of children hardly appears to require verbal description. Mr. M. Voss of Streatham has kindly communicated to me the results of his investigations.

Three years ago, some seed of the sensitive plant (*Mimosa pudica*) was set to grow, and at a moist heat of about 90° Fahr. it soon germinated. Before the compound foliage growth had commenced, the seedlings were potted off into different earths and sand. Those planted in a soil of two parts of decayed vegetable mould to one of sand grew more vigorously both in height and foliage than the others; and, after two months' growth, they were much less sensitive than others planted in two-thirds of silver sand and only one-third of leaf-mould. One or two plants were grown entirely in silver sand. These showed extreme sensitiveness to the slightest touch; even a breath of air, or the slightest jerk of the pot in which they grew caused all the foliage to shut up. Those plants having no nourishment beyond the gases in the air or sand soon turned yellow and died. The plants in two-thirds sand and one-third decayed vegetable mould were not so robust or strong as those grown in a greater proportion of vegetable mould. They failed to produce any flowers, and died off at the lower temperature to which all the plants were exposed; whilst those planted in two-thirds vegetable mould and one-third sand fully matured their growth, flowering in a temperature of 50° or 60°, the foliage being of that full green colour denoting the fact that the spongioles of the roots had necessarily been supplied with the various chemical gases in the soil (set free by a due amount of moisture) requisite for producing the continued support of the plants. Their sensitiveness had, at the end of August, almost left them; indeed, after a blow on the leaf with a twig, the foliage would fall, but almost immediately regain its horizontal position.

Many other useful analogies might, I think, be made in this direction; and the subject is one full of interest to all who look upon the conditions of health or disturbance of the system throughout the whole organised world. Among other matters, we might consider the transmission of sensitive impressions from one part of the plant to another; the metamorphosis of parts of a plant according to the functions discharged; the irritability or sensitiveness of plants, which is in some cases far greater than anything seen in man; the production of acid secretions in mobile plants; and numerous other facts easily observed in plants—facts of great interest to the physiologist and pathologist; and in this direction Mr. Darwin's researches, following those of Sachs, are a climax to investigations carried on since the time of Sprengel; facts which Sir James Paget would have us apply to the study of human pathology.

NERVE-STRETCHING IN INFANTILE PARALYSIS.*

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In bringing the subject of infantile paralysis before this Society, I do not propose to enter at length into the etiology or symptoms of the disease, but, by briefly recording the accepted views as to its pathology and treatment, attempt a justification of the treatment adopted in the case to be brought before you.

Numerous *post mortem* examinations have proved beyond question "that the earliest condition is one of subacute myelitis, with softening and destruction of the nerve-elements of the anterior cornua of the spinal cord exclusively. Some of the nerve-cells of this portion of the cord are sometimes filled with granular pigment-deposits, while others are disintegrated and broken up. The nerve-tubes of the anterior roots are found shrunken, the myeline absent, but the axis-cylinder nearly always intact. In other cases of longer standing, there are evidences of atrophy of the anterior horns, perhaps amyloid degeneration, and sometimes sclerosis. The nerve-cells are found in an atrophied condition or absent altogether" (Hamilton on *Nervous Disease*). However the disease may be caused, the multiple paralysis which may be observed at the beginning soon disappears, leaving behind a paralysis, or rather paresis, of some limb, or more often group of muscles, or perhaps only one muscle. With this paresis are associated a rapid atrophy of the affected muscles, and a lowering of temperature in the paretic part. Unless, as scarcely ever happens, a rapid recovery occur, the atrophy continues, and after a time the muscular tissue becomes replaced by connective tissue and fat. The blood-vessels diminish in size, and the bones do not develop in equal ratio with those of the corresponding limb on the other side of the body, but become friable and thin.

I may, I trust, be excused for recapitulating these trite facts to show the appalling nature of the disease, and the great need of the suggestion of useful treatment. Hitherto, any success attending treatment has been met with from the use of electricity, generally galvanism, to the spine, and faradism of the affected muscles. Success has attended such treatment, but unfortunately in so small a number of cases as to furnish no precedent for favourable prognosis. What the *rationale* of such treatment has been is difficult to understand, as, beyond keeping the muscles in working order by electrical stimulation, no direct benefit from spinal galvanism can, I think, be expected. The atrophied nerve-cells cannot be restored, or nerve-conductivity through the atrophied cornua re-established.

Peyer and Krause have found by experiments on rabbits, that most muscles are supplied by more than one root of a plexus; and Ferrier concludes that there are probably several spinal nuclei for the same muscle. If this be so, it is a possible explanation of the good results of electricity that, by stimulation, the other nerve-nuclei are induced to take on extra action, and supply the deficiency resulting from destruction of those anterior horns more particularly concerned in the government and nourishment of the affected muscles.

With these considerations in my mind, I asked Mr. Chavasse, on August 5th, 1881, to stretch the sciatic nerve of the patient I propose to show you. He is now five years old, and for three years has been under treatment for infantile paralysis affecting the right leg, at the General Hospital, Birmingham.

During the last two years, he has had continuous electrical treatment, with the result that, though the right leg has not kept pace in development with the left, there has resulted no deformity, and the muscles

* Read before the Birmingham and Midland Counties Branch.