THE CROONIAN LECTURES

ON

EVOLUTION AND DISSOLUTION OF THE NERVOUS SYSTEM.

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By J. HUGHLINGS JACKSON, M.D., F.R.S., F.R.C.P.,
Physician to the London Hospital.

Lecture III.

So far I have, for the most part, ignored the distinction between mental states and nervous states. I now pay particular regard to it. Here it is well to remark that, as Spencer says, "the doctrine of evolution, under its purely scientific form, does not involve materialism, though its opponents persistently represent it as doing so." He speaks of the materialistic hypothesis as being "utterly futile." To describe Spencer, Huxley, and Tyndall as materialists, is as absurd as speaking of Sir Joseph Lister as an opponent of antiseptic surgery would be. Spencer frequently insists on the absolute difference between states of consciousness and nervous states. Here is a most explicit declaration. After a consideration of increasing complication of mental states and nervous states, he writes (*Psychology*, vol. i, p. 403): "Of course, I do not mean that material actions thus become mental actions. As was said in Sections 41-51, 62, 63: 'No effort enables us to assimilate' mind and motion, I am merely showing a *parallelism*" (Italic in original) "between a certain physical evolution and the correlative psychical evolution." If any one wish to be thoroughly materialistic as to what is material, the nervous system, let him not be materialistic at all as to mind, which is not material at all. A man has both a mind and a body. On the principle of doing one thing at a time, I shall, in this lecture, first, speak of the body only. A man, physically regarded, is a sensori-motor mechanism. I particularly wish to insist that the highest centres—physical basis of mind or consciousness—have this kind of constitution, that they represent innumerable different impressions and movements of all parts of the body, although very indirectly, as certainly as that the lumbar enlargement represents comparatively few of a limited region of the body directly. It may be rejoined that the highest centres are "for mind." Admitting this, in the sense that they form the physical basis of mind, I assert that they are "for body," too. If the doctrine of evolution be true, all nervous centres must be of sensori-motor constitution. *A priori*, it seems reasonable to suppose that, if the highest centres have the same composition as the lower, being, like the lower, made up of cells and fibres, they have also the same constitution. It would be marvellous if, at a certain level, whether we call it one of evolution or not, there were a sudden change into centres of a different *kind* of constitution. Is it not enough difference that the highest centres of one nervous system are greatly more complicated than the lower? Some years ago, I asked the question: "Of what 'substance' can the organ of mind be composed, unless of processes representing movements and impressions? And how can the convolutions differ from the inferior centres, except as parts representing more intricate co-ordinations of impressions and movements in time and space than they do? Are we to believe that the hemisphere is built on a plan fundamentally different from that of the motor [and sensory] tract?" (*St. Andrew's Med. Grad. Reports*, 1870.) It is accepted, since the researches of Hitzig and Ferrier, that convolutions in the mid-region of the brain (which I call middle motor centres) do represent movements. It may, not without reason, be asked: Why should not also the more anterior parts of the brain, frontal lobes (which I call highest motor centres) represent movements? Recently, indeed, Ferrier and Gerald Yeo (*Pro. Royal Soc.*, January 24th, 1884) have concluded, from experiments on monkeys, that the frontal lobes represent some movements, and significantly these are lateral movements of the eyes and head—the most representative (in another sense of the word represent) of all movements. This is all the more significant, since many epileptic paroxysms (the discharge beginning in some part of the highest centres) begin by turning of the eyes and head to one side; and the more significant still when we bear in mind Beevor's observationst hat, in many cases of postepileptic coma, there is very transitory lateral deviation of the eyes from the side to which they turned in the prior paroxysm. Whilst, however, Ferrier agrees with me in thinking that the whole anterior part of the brain is motor, and that, to use his words, "mental operations, in the last analysis, must be merely the subjective side of sensory and motor substrata" (*Functions of the Brain*), as I have long earnestly contended, he does not agree with me in thinking there to be a division into middle and highest cerebral motor centres; and he thinks that what I call the highest motor centres represent only movements of the eyes and head, and not movements of all parts of the body, as I do.

In further exposition, I shall speak, for the most part, of movements only; for I believe that no one has ever denied that convolutions represent impressions (or, as is sometimes inaccurately said, sensations, or ideas made up of combinations of sensations). If the highest centres do not represent movements, it seems to me that the phenomena of an ordinary epileptic fit are unintelligible. Moreover, I think that the highest centres represent impressions and movements of *all* parts of the body. Neglecting impressions, this position seems to me to be supported by very different kinds of evidence.

1. I postulate that in an epileptic seizure, since consciousness is lost at or soon after its onset, the discharge begins in some part of the highest centres, the physical basis of consciousness. I do not say that in all epileptic seizures it begins in some part of the highest motor centres; these may no doubt be put in secondary activity by discharges beginning in parts of the highest sensory centres. I think it quite certain that epileptic attacks are not, and that epileptiform seizures are, owing to discharges beginning in parts of the mid-cortical region (middle motor centres). A consideration of the facts of epileptic paroxysms leads, I submit, to the conclusion that the highest centres represent, through the intermediation of the middle and lowest centres—that is re-re-represent—all parts of the organism in most intricate combinations. *a.* We see in a severe epileptic fit that all the skeletal muscles are put in vigorous activity—simultaneous development of innumerable different movements of all parts of the body. *b.* If we take a slighter case, one of *le petit mal*, we see that the effects of the central discharge are very widely, if not universally, distributed over the body; there are, in such cases, effects so various as spasm of ocular and hand muscles, pallor of the face, flow of saliva, perspiration, changes in the circulation (sometimes stopping of the heart's action, as Moxon has insisted), and arrest of respiration; there is often in, or just after, these slight fits, a discharge of fæces and urine. The existence, in some cases of *le petit mal*, of the voluminous mental states, so-called intellectual aura, spoken of in the last lecture (first depth of dissolution effected by an epileptic discharge), guarantees, so to speak, that the cruder effects just spoken of are owing to abnormal activity of the highest centres. The elaborate mental states mentioned, which, I suppose, no one will hesitate to ascribe to activity of "the organ of mind" (highest centres), never, so far as I have observed, occur in or after epileptiform seizures (discharges of middle motor centres). *c.* Then, if we take only the "warnings" of epilepsy, or rather of many different epilepsies, which "warnings" occur from, or attend, the beginning of the central discharge, we find them exceedingly various; there is giddiness, implying spasm of ocular muscles, or of some of those of the head; there are "crude sensations" of smell, sight, hearing, and taste. Besides these we find palpitation, a peculiar sensation referred to the epigastrium, and widely referred sensations of tingling, shuddering, and shivering. *d.* Another kind of evidence from cases of epilepsy is that, when a severe fit is over, there is some universal paralysis; at least, I contended so in my last lecture. Surely the several kinds of evidence point to the conclusion that the highest centres—the physical basis of consciousness—represent the whole organism.

2. There is a totally different kind of evidence which points to the same conclusion. Some medical writers speak of centres of volition, of ideational centres, of centres for reasoning (?), and of emotional centres; all four, of course, being cerebral centres. Whilst not believing in the least that there is a separate centre for each of these four "faculties," I will speak, for simplicity of exposition, as if there were. I now proceed to analyse, very briefly, not the mental states themselves, but their physical bases—nervous arrangements, which are in each, I submit, sensori-motor, triply indirectly representative of impressions and movements of parts of the body. I need, however, say nothing of the sensory element, for I suppose it will not be denied. *a.* The physical basis of volition consists of nervous arrangements, representing movements; the particular volition of the movement is, on the physical side, the survival of the fittest movement of the whole organism during activities of the centre for volition. The "centre of volition" is a centre representative of movements, particularly of movements of the arms, legs, face and eyes. *b. Ideational centres, or centres of memory.* Limiting myself to the simple cases of tactual and visual ideas, or images, the assertion is that the ideational centre

of necessity represents movements of the hands and eyes. That it represents manual and retinal impressions is, of course, certain; but that it also represents movements needs insisting on. No one ever touched anything (had a vivid tactual image) without moving his fingers; and no one ever saw anything (had a vivid visual image) without moving his eyes; therefore, in the anatomical substrata of what are called "ideas of objects," or better, "faint images," there will be represented movements of the hands and of the eyes. *c.* I confess that I never heard any one speak of a centre for reasoning; but, if there were warrant for believing in the existence of separate centres for the other faculties, I should think there to be greater warrant for believing in a centre for reasoning. Words serve us during reasoning; they are necessarily required in all abstract thought; this being so, the centre for words or for reasoning would consist especially of nervous arrangements representing highly complex and special articulatory movements.[1] *d. The emotional centre.* In strong emotional manifestations nearly all parts of the body are involved—not only the limbs, the facial, vocal, and respiratory muscles, but also many internal organs. The emotional centre will then represent an exceedingly wide range of movements. During fright there are pallor, palpitation, and hurried respiration; occasionally, there is a passage of feeces; there is dry mouth; there is increased sweat with coldness of skin.[2] The popular explanation would be that there is an emotional centre which is not representative of the parts concerned in the manifestations, but that its activity produces the manifestations by acting on lower centres, which alone represent those parts. The more realistic view, I submit, is that an emotional centre itself represents, although very indirectly, the parts of the body concerned in different emotional manifestations, and that the emotion arises during the central activities which, through subagency of the middle and lowest centres, produce the manifestations.

Now, not believing in the existence of the four separate faculties, but holding that will, memory, reason, and emotion are simply artificially distinguished aspects of one thing, a state of consciousness. I say that, instead of four centres, there are highest centres; and that, during activity of these centres, will, memory, reason, and emotion are simultaneously displayed; or, in strictly equivalent words, that there arises a state of consciousness. If so, then, putting together the "four centres," and their motor representations, we have, altogether, obtained highest centres representing (1) movements, especially of the arms, legs, and face; (2) movements of the hands and eyes; (3) articulatory movements; and (4) movements of many parts of the body, animal and organic. The conclusion from this evidence, very imperfectly and incompletely stated I admit, is that the highest centres represent, at any rate, very many, and certainly most different, parts of the body. The two utterly different kinds of evidence converge to the same conclusion. Taking them together, we see that there is no incongruity in asserting that both epilepsy and insanity are diseases of the highest centres. In health, will, memory, reason, and emotion, or, in other words, a state of consciousness, arise during slight sequent activities of sensori-motor nervous arrangements of the highest centres, representing all parts of the body. An epileptic seizure is owing to a sudden and excessive discharge of very many of these sensori-motor nervous arrangements nearly simultaneously. During such discharges, consciousness ceases, and from them, taking into account secondary downward discharges of middle and tertiary discharges of lowest centres—there results that contention of innumerable movements of all parts of the body, which we call universal convulsion. Taking a case of insanity which, like epilepsy, is a disease of the highest centres, the averment is that the negative element, defect of consciousness, implies loss of, or loss of function of, for illustration, the topmost layer of the highest centres. This, on the hypothesis that the highest centres are sensori-motor, is causative of some trifling widely distributed paralysis. The positive element (illusions, etc.) is mentation or consciousness going on during activity of the lower level remaining, second layer. This, the highest mentation then possible, occurs during activities, stronger than normal, of sensori-motor nervous arrangements, but activities incomparably less strong than those productive of convulsion. Were, in the case of insanity, the second layer, or part of it, to discharge suddenly and excessively, as occurs in an epileptic fit, even insane mentation would cease during the discharge, and convulsion would result from it. This is an old conclusion, as the following quotation shows. At that time I did not, not having the advantages of the researches of Hitzig and Ferrier, divide the brain into middle and highest centres. As the words now intercalated show, I did not then distinguish clearly the mental from the physical.

"Surely the conclusion is irresistible, that mental symptoms, from disease of the hemisphere, are [on the physical side] fundamentally like hemiplegia, chorea, and convulsions, however specially different. They must all be due to lack of, or to disorderly development of, sensori-motor processes." (*St. And. Med. Grad. Trans.*, 1870.)

It may be objected that, during most mentation, there are no movements. It will be borne in mind that I said that the nervous arrangements of the four centres, together the highest centres, represent parts of the body triply indirectly. The middle and lowest centres are not only "reservoirs of energy," but also "resisting positions." All that is contended for is, to take the case of visual ideation, and neglecting the sensory element, that there are slight excitations of nervous arrangements triply indirectly representing movements of the ocular muscles, but excitations not strong enough to overcome the resistance of the middle centres. When ideation rises into perception, there is, physically, a stronger discharge of the same nervous arrangements of the higher centres, so that the middle and then the lowest centres are overcome. I speak of this subject again, after considering reflex actions in which the highest centres are engaged.

I now speak again of degrees of organisation, especially as to the highest centres, which are the least organised. I have pointed out that there is no difficulty in supposing that these centres may be the most complex, and, at the same time, the least organised. If the highest centres were already organised, there could be no new organisations, no new acquirements. I will now illustrate the process of dissolution with regard to degrees of organisation. It may be contended that alcohol, in a small quantity, "excites," although it is granted that, in a large quantity, it produces coma. It may be said that the boisterous conduct of a drunken man occurs because alcohol has goaded certain nervous arrangements of his highest centres into activity, and that it is not, as Anstie supposed, the result of permitted increased activity of a lower and more organised level of evolution consequent on exhaustion of the higher, the less organised. Let us take a case free from ambiguity—a case of simple fatigue. A very good example of what would be popularly called "increased activity" of the brain "from debility," is given in *Greater Britain*. "This evening, after five sleepless nights, I felt most terribly the peculiar form of fatigue that we had experienced after six days and nights upon the plains." Observe, the writer calls his condition fatigue. "Again the brain seemed divided into two parts, thinking independently, and one side putting questions while the other answered them; but this time there was also a sort of half insanity, a not altogether disagreeable wandering of the brain, a replacing of an actual by an imagined ideal scene." Popularly, we say that the condition was caused by fatigue—five sleepless nights; but I submit that the more reasonable explanation is that fatigue caused only the negative physical state, answering to the negative part of the mental condition, the loss of the "actual scenes," and that the "ideal scenes" which "replaced" them occurred during activity of lower, more organised, nervous arrangements, uncontrolled by the exhausted highest. It seems to me that Anstie's principle applies clearly here. I may instance a more extreme case. Delirium sets in during starvation; surely it cannot be contended that from total withdrawal of food certain nervous arrangements attain greater activity? If they do, we have still to account for the negative part of the starved man's delirious condition. Does innutrition "cause" two diametrically opposite and yet co-existing states of the nervous system? Anstie's principle accounts for both.

The next pair of terms I consider are voluntary and automatic. The expression "most voluntary" is very objectionable. It is a compound of a psychological and of a physiological term. Instead of it, I suggest the expression "least automatic," which is rigidly equivalent to what is called "most voluntary." This is stated in effect by Herbert Spencer in the remark that the "cessation of automatic action and the dawn of volition are one and the same thing" (*Psych.*, vol. i, p. 497). Volition arises during activity of the least automatic nervous arrangements; or, rather, "a kind of mental action arises which is one of memory, reason, feeling, or will, according to the side of it we look at" (Spencer, vol. i, p. 495). So now we say that the progress in evolution is from the most to the least automatic, and thus that the

[1] It is not meant that a word, which is a psychical thing, is an activity of any nervous arrangements for highly special and complex articulatory movements, but that such nervous arrangements (or, rather, audito-articulatory nervous arrangements) are the physical bases or anatomical substrata of words. I believe that these articulatory movements are represented largely in Broca's region, but yet over again in the highest motor centres.

[2] I believe that the positive effects are owing indirectly to exhaustion of nerve-fibres effected by a prior sudden discharge, holding that there is a negative and a positive element in the physical condition for fright; for example, the palpitation may be owing indirectly to exhaustion of the inhibitory fibres of the vagus, the passage of feeces indirectly to exhaustion of the splanchnics; the two positive symptoms are owing to permitted over-activity of lower centres, consequent on removal of control.

highest centres are the least automatic. It is not a mere question of words. The substituted expression does not imply an abrupt division into the voluntary and the automatic, but implies degrees from most to least automatic, and that a man, physically regarded, is an automaton, the highest parts of his nervous system (highest centres) being least automatic; the substituted term does not bring the will, a psychical state, into a purely physical sphere.

A perfect automaton is a thing that goes on by itself. There are degrees from those nervous arrangements, which almost go on by themselves to those which come into activity by the aid of other, lower, more organised, nervous arrangements. To say that nervous arrangements go on by themselves, means that they are well organised; and to say that nervous arrangements go on with difficulty, if at all, by themselves, is to say that they are little organised. Hence degrees from most to least automatic are, on another aspect, degrees of organisation from the most to the least. Repeating what has been already said in effect, if the highest centres were perfectly automatic, there would be no such thing as a "voluntary" operation: all being organised, there would be no possibility for correct adjustments in new circumstances; we should be ready adapted to particular external conditions, but no new adaptations to new conditions could occur.[3] The becoming more perfectly organised, and, the becoming more automatic, are only different sides of one thing; a commonplace illustration is learning to write. There are degrees of automaticity from those operations inherited comparatively perfect, through, so to speak, the secondary automatic (writing, for an example) up to the activities of those least automatic nervous arrangements which are concerned during one's present thinkings and doings. We may say that there are degrees from most organised and most automatic nervous arrangements, up to nervous arrangements just begun—nerve-stuff being, for the first time, travelled by nerve-currents.

To illustrate dissolution, from this point of view, would be essentially a repetition of former illustrations, given after speaking of degrees of organisation. I would observe here that, in using such an expression as "*the* automatic" we must bear in mind that what is very automatic to one man is not automatic to another. This is either a truth or a truism, as we apply it. When a patient is delirious, say during acute non-cerebral disease, and goes through, in pantomime, the manipulations of his trade, although these operations are exceedingly elaborate in themselves, they are not elaborate to him. They have become deeply automatic, and go on very much by themselves in health; in consequence, in spite of their elaborateness, the persistence of only such actions implies a deeper dissolution than the persistence in another patient of actions equally elaborate, which had not in him become automatic.

I pass over the two antithetical terms, "general" and "special," and also another pair, "complex" and "simple." We now come to the doctrine of reflex action. The term corresponding to "most organised" and "most automatic" is "most perfectly reflex;" that corresponding to "least organised" and "least automatic" is "least perfectly reflex."

Degrees of automatic action answer to degrees of independency of nervous arrangements, from those almost going on by themselves, and nearly independently of all others, to those put in action by others, most dependent on all others. Degrees of reflex action are degrees of nervous arrangements going on according to degrees of stimuli coming to them. No doubt the distinction is to a very great extent artificial; but it is a convenient one. In further remarks, I limit myself entirely to reflex actions in which the highest cerebral centres are necessarily engaged. Here we make a division of these: 1, complete and strong, those in which the highest centres are strongly engaged along with all lower centres; 2, incomplete and weak, those in which the highest centres are alone engaged, and are in but slight activity. Beginning with an artificially simplified case of complete and strong reflex action, I suppose that I am seeing a brick: this is sometimes called a "perception;" I prefer the expression, that I have a vivid image. So far we have spoken of a mental event; now for the correlative purely physical event, which is a reflex action occurring during, or rather effecting, a correspondence of the organism with the environment (the process is really double). What first happens is that there is a peripheral impression (upon the retina), impulses then pass through the lowest, through the middle, and up to the highest sensory centres. It should be particularly observed that there is passage from the most organised to the least organised centres; from the least modifiable to the most modifiable; there is a multiplication of energy-liberations upwards, and consequently strong excitation and wide irradiation in the highest sensory centres. So far we have only stated one half of the reflex action, have only reached the physical condition in the highest sensory centres correlative with the colour of the brick. It and all other objects have shape, and this as much requires to be accounted for as the colour. The shape of an object is the relation of its several positions one to another; our knowledge of this relation is by movements, in this case ocular movements (symbolising some movements of the hands).[4] By currents passing from the highest sensory centres, so to speak, "across" to the highest motor centres, and from these downwards, through middle and lowest motor centres to muscular periphery, there is development of movements of the eye-balls; the process in this stage is from the least to the most organised, from the most modifiable to the least modifiable; there is a limitation of energy-liberations downwards, and thus from wide excitations in the highest centres there result movements limited to a part of the periphery. Here we have complete and strong reflex action, complete because all orders of centres, sensory and motor, are engaged; and strong, because the highest centres are in great activity, consequent on the multiplication of energy-liberations upwards.

This is a purely physical process. The vivid image, the mental state we have, arises during (not from) the physical condition in the two divisions of the highest centres, and is strongly and definitely "projected," because the lower centres are engaged; it *seems* part of the outer world. Next day, we can think of the brick in its absence, have "an idea of it," or, as I prefer to say, have a faint image, where, yesterday, we had a vivid image. In this case, the reflex action is incomplete and weak; the lowest and the middle sensory centres and the middle and lowest motor are not engaged. The highest sensory and motor centres are alone engaged; there is still reflex action, but only the central links of the sensori-motor chain are engaged; the central part only of the whole process which occurred in perception is done over again, and, the excitations being slight, the image arising is faint, and, the lower centres not being engaged, it is feebly and indefinitely projected, *seems* more part of ourselves.

Let us see how the doctrine of reflex action applies in the elucidation of the phenomena of an epileptic fit, and thus illustrate again, on a small scale, the dictum that an epileptic fit is owing to an excessive discharge beginning in some part of the anatomical substrata of consciousness. Let us imagine, which for my own part I do not believe, that there is a centre for visual ideation and nothing else—a centre made up of the anatomical bases of visual images only. We "store up" images of innumerable different objects, each of which has some colour and some shape; this means, on the physical side, that the centre we are imagining contains innumerable nervous arrangements, each of which represents a different retinal impression, and a different ocular movement; these are, anatomically, sensori-motor (retino-ocular) nervous arrangements; physiologically, they are reflex actions. During slight activities of this centre, unprovoked from the periphery, (incomplete and weak reflex actions) we have faint visual ideas; during strong activities provoked by peripheral agencies leading to reactions on the periphery (complete and strong reflex actions), we have vivid visual ideas (the parts of the highest centres concerned during perception and during ideation are the same). So far for two degrees of healthy activity. Now, suppose that some of the cells of the nervous arrangements of these centres, by any pathological process, become highly unstable, to a degree such as occurs in epilepsy. The consequence will be that many nervous arrangements occasionally discharge suddenly, excessively, and simultaneously. During such a discharge, there would not arise images of many objects, differently coloured and shaped; but, on the contrary, there would be crude masses of vivid colour before the eyes, and there would also be a strong development of many ocular movements at once—that is to say, convulsion of the muscles of the eyeballs. Some epileptic seizures do begin by the patient having vivid colour before his eyes; spasmodic turning of the eyes to one side is not an uncommon onset.

There is another matter of vast importance. The pairs of terms on which I have spoken, and some others which I have passed over, are, I think, parallel in meaning, but may not seem so at first glance. We have to mention that evolution is not a necessary process; it depends on conditions. Evolution, so to speak, is not an "even" gradually increasing complexity, etc., from bottom to top. We develop as we must, that is, according to what we are by inheritance; and also as we can, that is, according to external conditions. There is something more: there is what I will call Internal Evolution, a process which

[3] The becoming more automatic is not dissolution, as I believe some think it to be, but is, on the contrary, evolution becoming complete. The highest centres are the most complexly evolving, but are also the least perfectly evolved. In other words, the highest centres are "the ravelled end." In them evolution is most actively going on, whilst in some lowest centres, *e.g.*, the respiratory, evolution is probably nearly completed.

[4] In seeing a small object, there may be only excitation of motor nervous arrangements in the highest centres, not passing downwards to middle and lowest.

goes on most actively in the highest centres. On account of its great preponderance in the highest centres of man, he differs so greatly from lower animals. We acquire numerous different ideas: that is to say, there is, on the physical side, an organisation of many different nervous arrangements of our highest centres, during actual converse with the environment. When, as in sleep and in "reflection," this actual converse ceases, the quasi-spontaneous slight activity of the highest sensory centres is uninterfered with by the environment, they being protected from it by the lowest and middle sensory centres; and, consequently, there are no reactions on the environment, the highest motor-centre being resisted by the middle and lowest centres; in such case (sleep, reverie, reflection, etc.), the very highest nervous arrangements of the highest centres, those in which entirely new organisations can be made, will be in least activity, and the next lower of those centres in greater activity. The nervous arrangements of the highest centres, or some elements of them, are "left to fight it out among themselves;" new combinations arise, the survival of the fittest. Manifestly new, although evanescent combinations, are made during dreaming; but I contend that permanent rearrangements (internal evolutions) are made during so-called dreamless sleep (I believe that the late Dr. Symonds, of Bristol, stated this in effect). Internal evolution is supposed to go on in all centres; perhaps, as to some centres, such as those for micturition and defæcation, we may say that it has been almost completed; they are nearly autonomous at birth, and are but slightly, I imagine, represented over again in the higher centres, but are much under their inhibition. The doctrine of internal evolution, I submit, accounts for what, at first glance, seems the inadequate number of fibres from lowest centres towards highest. In the highest centres will be a great number of sensori-motor combinations, which do not answer to any actually experienced correspondencies with the environment, and which on their normal excitations do not lead to actual movements; and, in the case of many lowest centres, there will be sensori-motor nervous arrangements for purely "local affairs," which will, I imagine, require little re-representation in the higher centres. Since most mentation, ordinarily so called, is carried on in visual and tactual ideas, or in words, internal evolution in the highest centres leads to a great multiplication of nervous arrangements representing ocular, manual, and articulatory muscles; this is repeating in another way the statement that small muscles are very largely represented in the highest centres.[5] Mentation involves emotion; as the highest emotions are (Spencer) compounded out of the lower, there will be, on the physical side, in man a large re-representation in his highest centres of the organic parts concerned during emotional manifestations. These statements as to very large representations of small muscles and of organic parts in the highest centres accord with the facts that in slight epileptic fits —comparatively slight discharges, beginning in parts of the highest centres—the skeletal muscles chiefly convulsed are the small muscles spoken of; and that there is a very extensive involvement of the organic parts. We have, I think, in the doctrine of internal evolution, an explanation of the disproportionate involvement of organic parts in slight epileptic attacks.[6] In those parts of the middle motor centres especially representing small muscles, there are (Bevan Lewis) most small cells (I suppose these will be paths of least resistance). Whether the like obtains or not in the highest motor centres, I do not know.

So far, I have, as much as possible, considered a man as a mere machine. I have often, it is true, in preceding remarks, used psychological terms; but I have really been dealing only with the nervous system—have been speaking of the physical conditions underlying mental states. Now, I speak of the relation of consciousness to nervous states. The doctrine I hold is: first, that states of consciousness (or, synonymously, states of mind) are utterly different from nervous states; second, that the two things occur together—that for every mental state there is a correlative nervous state; third, that, although the two things occur in parallelism, there is no interference of one with the other. This may be called the doctrine of Concomitance. Thus, in the case of visual perception, there is an unbroken physical circuit, complete reflex action, from sensory periphery through highest centres back to muscular periphery. The visual image, a purely mental state, occurs in parallelism with—*arises during* (not *from*)—the activities of the two highest links of this purely physical chain; so to speak, it "stands outside" these links.

It seems to me that the doctrine of concomitance is, at any rate, convenient in the study of nervous diseases. It, or an essentially similar doctrine, is held by Hamilton, J. S. Mill, Clifford, Spencer, Max Müller, Bain, Huxley, Du Bois Raymond, Laycock, Tyndall, Herman, and David Ferrier. Those who accept the doctrine of concomitance do not believe that volitions, ideas, and emotions produce movements or any other physical states. They would not say that an hysterical woman did not do this or that because she lacked will; that an aphasic did not speak because he had lost the memory of words; and that a comatose patient did not move because he had lost consciousness. On the contrary, they would give, or try to find, materialistic explanations of physical inabilities. I do not try to show what is the nature of the relation between mental and nervous states.

The next question is as to range of concomitance. How "far down" in the nervous system does consciousness extend? Lewes thought that some degree of consciousness or "sensibility" attended activities of even the lowest centres. The current view is, that it only attends activities of the highest parts of the nervous system, although no lower limit is agreed upon. Some, indeed, speak of "unconscious states of mind," as if, below consciousness, there were some faint mental states. I am not sure that I state this view with verbal correctness, as I do not understand it. That activities of the highest, least organised, nervous arrangements, during which consciousness, or most vivid consciousness arises, are determined by activities of lower, more organised, nervous arrangements, I firmly believe. As I have said, in effect, states of consciousness attend survival of the fittest states of centres representing all parts of the organism as one whole. Roughly speaking, the highest nervous states are determined from below, and not by autocratic faculties acting upon the highest parts of the highest centre. But whether the activities of the lower nervous arrangements have attendant states of mind, however faint or not, is disputable. Less consciousness attends activities of nervous arrangements the more organised and automatic they are or have become, which means that the highest, least organised, least automatic, most imperfectly reflex centres, are the physical bases of consciousness or of most vivid consciousness.

[The lecturer then spoke of those disorders of co-ordinations which occurred only when movements were attempted—started by volition, or, speaking realistically, by discharges beginning in parts of the highest centres. (He did not believe that there was a difference in kind between inferior centres representing impressions and movements, and superior centres co-ordinating them; the so-called superior co-ordinating centre was one where impressions and movements represented in the inferior centre were re-represented in more complex and special combinations.) All the disorders of co-ordination spoken of, he thought, were essentially cases of paralysis; that is, in the sense of there being loss of some movements; there was also an over-development of other movements, consequent on greater energising of healthy nervous arrangements; the two elements, negative and positive, constituted the disorder of co-ordination. Here again was seen, but in another way, the importance of taking note not only of the dissolution, but of the levels of evolution (lower, or higher, or collateral) remaining. He illustrated his hypothesis as to the disorders of co-ordination mentioned by the case of paralysis of the right external rectus muscle, pointing out that, as an indirect consequence of this purely negative state, there was an over-positive effect on the internal rectus of the left eye (secondary deviation); an ordinary discharge starting in the highest centres failed to turn out the right eye; there being a stronger discharge, there was still no effect on the right eye, but the left turned in too much. Here the direct effect of the negative lesion and its indirect over-positive effect, were seen nakedly separate; but he believed that in cases of disorder of co-ordination, where the same muscles were involved, the principle held; there may be loss of some movements of a set of muscles, and retention of other movements of them. He supposed that in writers' cramp there was some paralysis, in the sense of loss of but a few of the most special movements of writing, represented in some lowest centres, from atrophy of their cells consequent on over-use—that is, abuse. As a result, there was greater energising of the highest centres coming down to compel the atrophic elements of the lowest centres to act. No effect being produced on these elements, the most special of the movements of writing were not developed, but there was an over-development of the more general movements of the same and other muscles, represented in the same and other lowest centres. He thought that the essential condition of things in the reel in destruction of part of the middle lobe of the cerebellum was loss of some movements of the spine, was some paralysis; the erratic movements of the legs were, he thought, consequent on discharges of healthy nervous elements.

[5] It is well known that, after amputation of a limb, the patient retains a phantom limb, or part of one. According to Weir Mitchell, the parts most often remaining spectrally are the terminal parts—the parts having most small muscles. The part of the limb above up to the stump often does not remain spectrally. Here is some further evidence of the especially great representation of parts having small muscles in the highest centres.

[6] What I have described as internal evolution is, I think, essentially the process of which Spencer speaks in chapter 6, Physical Synthesis, *Psych.*, vol. i. I particularly refer to section 246.

The lecturer then stated his opinions as to Localisation, limiting consideration to movements. For illustration, he imagined a centre for the arm and the leg. The "Universaliser" would say that every part of the centre represented both the arm and the leg in the same way; the "Localiser" would say that one part of it represented the arm only, and another part the leg only—would, indeed, make two centres. This is the current hypothesis. The lecturer did not take either of these views; he restated the opinion which he had held as to localisation, both before and since the recent experiments of Hitzig, Ferrier, and others on the mid-cerebral cortex.

"It may be said that one convolution will represent only the movements of the arm, another only those of speech, another only those of the leg, and so on. The facts above stated show that this is not the plan of structure of the nervous system. Thus, to take an illustration, the external parts, x, y, and z, are each represented by units of the corpus striatum. But the plan of representation is not that some units contain x largely only, as x_3, others y largely only, as y_3, but that each unit contains x, y, and z—some, let us say, as x_3, y_2, z; others as x_2, y_3, z, etc. When we come to the still higher evolution of the cerebrum,[7] we can easily understand that, if the same plan be carried out, a square inch of convolution may be wanting, without palsy of the face, arm, and leg, as x, y, and z are represented in other convolutions; and we can also easily understand that discharge of a square inch of convolution must put in excessive movement the whole region; for it contains processes representing x, y, and z, with grey matter in exact proportion to the degree of complexity." (*St. Andrew's Medical Grad. Trans.*, 1870.) This is only another way of stating the doctrine of compensation and its "inversion," co-operation in excess (see second lecture). This double doctrine, he thinks, applies to representation of movements in the mid-cerebral region of dogs. Destruction of a part of the dog's mid-cortex entails no permanent paralysis, but discharge of any part of it produces convulsion. Ferrier, Charcot, and others have shown, since the part quoted was written, that destructive mid-cortical lesions in monkeys and men entail some permanent local paralysis; in these animals, it would seem that there is less compensation than in dogs. The important question is—Is there some recovery, and thus some compensation, in the case of man? The lecturer did not now suppose compensation for any destructive lesion to be ever absolute. His hypothesis was that the so-called centre for the arm represents that part very specially, but that it also represents the leg and face more generally, and the parts on the other side of the body still more generally; similarly, *mutatis mutandis* for the other centres. According to this view, destruction of the arm-centre should entail some decided paralysis of that limb, and very little, if any, of the leg and face, which two parts would have also a large representation in, so to speak, their own more particular centres. On the other hand, excessive discharge limited to the arm-centre should produce convulsion, beginning in that limb, and yet spreading beyond it to the leg, face, etc. The currents developed would, however, not be limited to one centre; they would, no doubt, spread to collateral centres, and discharge them; thus a convulsion beginning in the arm and becoming universal, was no evidence that a single centre—the arm-centre—represents all four limbs.[8] Yet certain experiments by Franck and Pitres on dogs tended, the lecturer thought, to show that his view of localisation—that every centre represented all parts, but that each centre represented some one very specially—held in the case of those animals. They conclude from these experiments: "Elles démontrent, en effet, que l'épilepsie peut se généraliser bien que l'excitation provocatrice ait été limitée à un seul centre cortical [they isolated the arm-centre, and by stimulation of it produced convulsion of all four limbs] et que la destruction préalable d'un centre cortical [they cut out the arm-centre in another experiment] n'empêche pas l'extension des convulsions aux muscles correspondant au centre préalablement détruit."

It must be said that these distinguished physicians believe, as stated in the first lecture, that, "Le cerveau commence l'attaque, la protubérance, le bulbe et la moelle la généralisent." Ablation of the cortical centre, "primitivement excite" does not (Albertoni, Franck, and Pitres) stop the convulsions. Franck and Pitres' argument is very able and powerful; their contention deserves most respectful consideration. No doubt centres in the pons, medulla, and spinal cord (lowest centres), are discharged by the prior cortical discharge. At any rate, the experiments mentioned go towards showing that *all* the lowest centres are under the command of—if they are not all, as the lecturer thinks, re-represented in—*each* part of the mid-cortex. The order of the discharge of all the lowest centres is determined by the particular part of the mid-cortex primarily discharged.

Admitting difficulties in the way of acceptance of his hypothesis of localisation, the lecturer thought the current hypothesis did not account for all the facts. Any adequate hypothesis had to account for the following: (1) that from a destructive lesion of motor centres the paralysis was especially of the more voluntary, etc.; (2) that from a discharging lesion, the development of movements (convulsion) was the same: an epileptiform seizure starting in the arm began, first of all, in the hand; one starting in the leg began in the foot; one starting in the face, in the side of the mouth; (3) that the progress in each (1 and 2) was in compound order; (4) that a part might be permanently imperfectly paralysed, and yet the whole of it might be occasionally convulsed; (5) that recovery, or some recovery, follows on permanent destructive lesions producing paralysis; there is often at least some compensation; (6) that a small destructive lesion of a motor centre may entail little or no obvious paralysis, whilst a sudden and excessive discharge beginning in such part produces (indirectly) very great convulsion; (7) that from discharges beginning in different parts of the mid-cortex, we have fits affecting the same regions, but their parts in different order ("isomeric seizures"); (8) that a patient, who has no paralysis before a convulsion, has much (temporary) paralysis after it. (Cases of monoplegia [the paralysis only existing after a convulsion] must not be adduced as evidence to show that any lesion found *post mortem*, say a tumour, had produced paralysis by its direct, its destructive, action.)]

[7] At that time, I arranged centres morphologically, and did not then make a division into highest and middle motor centres. I used to speak of convolutions being the corpus striatum "raised to a higher power." As stated in the second lecture, I now arrange centres on an anatomico-physiological basis.

[8] Of course, the term "centre" is an arbitrary expression; but using the term "centre for the arm," there would in it, one must suppose (judging from the mode of spreading of convulsion in that limb from discharge beginning in part of the centre), be subcentres.

THE LUMLEIAN LECTURES
ON
THE ÆTIOLOGY OF PHTHISIS.

Delivered at the Royal College of Physicians.

By J. ANDREW, M.D., F.R.C.P.,
Physician to St. Bartholomew's Hospital.

LECTURE II.

THE causes of phthisis which come next under consideration are those connected with modes of life and industrial occupations. A mere enumeration will be almost sufficient in the case of the majority of the members of this group. It is all but impossible to separate the influences of the day-workshops and of the occupations from that of the houses, and especially of the sleeping-rooms, of the operatives, so that whatever arguments on either side might be drawn by a confident statistician could be of little value. The conclusions could scarcely be of greater weight than the premisses. Still, as the influence of the home-life is probably about the same as all occupations which are paid at the same rate, except, of course, those which must, from their nature, be carried on in specially unhealthy localities, it would be reasonable to attribute, in part at least, to the occupation any great variation from the phthisis-mortality in either direction; although it might be impossible to determine the exact proportion in which the conditions of labour and of home-life contribute to it. Still more justifiable would it be to do so in cases where general rules, such, for example, as that phthisis in country districts is more frequent among women, are interfered with. With these limitations, I would divide this group into two subgroups, viz.:

1. Those occupations and modes of life in which there is the possibility, the likelihood if you will, that direct contagion may come into play;

2. Those in which there is no greater danger of such contagion than all of us are exposed to in the ordinary intercourse of life.

1. All modes of life, all occupations which are carried on indoors, contrast unfavourably with outdoor pursuits. The naked savage, whatever ills he may have to bear, rarely finds phthisis among them; but with every addition to his clothing, and to the comfort of his tree or cave, his proneness to it increases. In this respect, in an advanced civilisation, the effeminacy or luxury of the rich and the necessities of the poor bring about the same result. Sometimes, perhaps, even members of our own profession are forgetful, in the advice they give, of the advantages of an open-air life. I remember more than one medical student with incipient phthisis, compelled by circumstances to undertake country practice in a bleak district, who, instead of being