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REMARKS ON

EVOLUTION AND DISSOLUTION OF THE

NERVOUS SYSTEM.

BY

J. HUGHLINGS JACKSON, M.D., F.R.C.P., F.R.S.,

Physician to the London Hospital and to the National Hospital for the Epileptic
and Paralysed.

Reprinted from "The Journal of Mental Science," April, 1887.

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REMARKS ON EVOLUTION AND DISSOLUTION OF THE NERVOUS SYSTEM.

By J. HUGHLINGS JACKSON, M.D., F.R.C.P., F.R.S.,

Physician to the London Hospital and to the National
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(1) *The Universal Symptomatology of an Epileptic Fit owing to discharge beginning in some part of the highest cerebral centres.*—There is but little doubt that in a severe epileptic paroxysm ("genuine epilepsy") there are effects, although very crude ones, produced in, or referred to, all parts of the body, animal and organic. Speaking figuratively, there is an endeavour to develop activity of all parts of the body excessively, and of all of them at once,* and as rapidly as possible.

Consciousness begins to cease, that is to say mind begins to cease, at or soon after the onset of the paroxysm; equivalently there is no warning, or a transitory one. I take this as proof that the correlative physical event, the sudden and excessive discharge which produces universal effects, begins in some part of the "organ of mind" or physical basis of consciousness—that is to say, in some part of the highest centres of the cerebral system. It is well to give other

* I have gone into this matter at length in the Bowman Lecture, delivered Nov., 1885, and published in "*Ophthalmological Society's Transactions*," Vol. vi. I do not mean that there is demonstration that literally all parts are involved.

synonyms, so we add that the discharge begins in some part of the latest evolved (the continually evolving) centres—highest level of evolution of the cerebral system.

The severe epileptic fit is dissolution, universal or nearly so, being effected. The post-paroxysmal condition, post-epileptic coma, is such dissolution effected. There is not total dissolution unless the patient dies. The patient universally convulsed in the paroxysm is after it universally, not totally, paralysed, and is insane, viz, demented. Perfect dementia, or, I suppose I should say, amentia, is, to my thinking, synonymous with absence of all consciousness and with total mindlessness (Section 14). Dementia is chronic persisting coma; coma is acute transitory dementia.* Recovery from post-epileptic coma is re-evolution from universal and almost total dissolution (from what is often nearly, if not quite, psychical death, and from what is nearly physical death).

(2) *Different Epilepsies (The Scale of Fits; "Discharging Lesions")*.—Before going further I would remark that, although I shall continue to speak for the most part of epilepsy as if there were one such clinical entity, there are really many different epilepsies (I mean what would be called "varieties" of "genuine" epilepsy), each dependent on a "discharging lesion" of some part of the highest centres. Epilepsies are only one class of fits (Highest Level Fits). To prevent confusion, I must mention the other classes, and thus complete what I call the Scale of Fits. There are, as everybody admits, different epileptiform seizures from "discharging lesions" of different parts of the middle motor centres (Middle Level Fits). There are, I think, different fits (bulbar fits, laryngismus stridulus for one example) dependent on discharges beginning in different parts of the lowest level of central evolution (Lowest Level Fits).

I use here the most general term I can find, "fits," advisedly, because I do not, as I should when working clinically, care, as an evolutionist, to know whether any paroxysm is or is not "a case of epilepsy," nor how near it approaches

* Certain qualifications will be given to these statements later on. "Coma is a fulminant form of insanity; insanity is a lingering form of coma. Pathologically, coma is loss of function of the nervous centres, beginning in the highest centres of all; in those centres, which are the substrata of consciousness which effect the adjustment of the organism as a whole to its environment, which represent, first and most, the most precise and elaborate bodily movements, and which represent in some degree every part of the organism."—*Dr. Mercier, Brain, January, 1887, p. 483.*

the clinical type of "genuine" epilepsy. As an evolutionist, I wish to learn how cases shew *departures from normal states*, and how the three classes of fits resemble and differ as results of discharges beginning on three different evolutionary levels. Whether consciousness is lost or not is not the matter of first moment; it is lost in severe fits of each class. Obviously the comparative study indicated is involved. For in a severe epileptic fit, to take that as an example, the discharge beginning in some part of the highest level will discharge parts on the middle and next parts, on the lowest level, and finally the muscles will be discharged. So that such a paroxysm is triply compound, or quadruply, if we take into account the discharge of the muscular periphery, the real lowest level. The paralysis after such a fit will be very compound.

Certainly there are as many epilepsies (Highest Level Fits) as there are paroxysms setting in with different "warnings." The "warning" is a sign of the locality of the "discharging lesion" ("physiological fulminate"); it is the first event in the paroxysm occurring from, or during, the incipient discharge. The "discharging lesion" I hold to be a persistent local change of some nervous arrangements; the few cells making it up varying in their degree of tension from that of very high instability, permitting sudden and excessive discharge, to that, after their discharge, of stability far below normal. In all cases of epileptiform and epileptic seizures the "discharging lesion" is supposed to be of some small part of one half of the brain, and is thus, so to speak, doubly local. A very small local "fulminate" in but one half of the brain, when suddenly and rapidly discharged, can, by overcoming the resistances of healthy nervous arrangements, set up discharges of so many of these healthy nervous arrangements, associated collaterally and downwardly with those altered into the fulminate, that severe universal convulsion results.

(3) *Different Insanities; Local Dissolutions of the Highest Centres.*—Similarly we should, in strictness, speak not of varieties of insanity, but of insanities; for obviously there are different kinds as well as degrees of insanity—that is, there are dissolutions beginning in different divisions of the highest centres. Melancholia (posterior lobes?) and general paralysis (anterior lobes?) signify different *local* dissolutions of the highest centres as certainly as brachioplegia and cruroplegia signify different local dissolutions of the middle motor

centres, or as ophthalmoplegia externa and ordinary progressive muscular atrophy signify different local dissolutions of the lowest motor centres. Here is hinted at a "scale of paralyses," on which we speak later. (Sections 10 and 18).

(4) *Evolution and Dissolution always coexist or occur in alternation ; Different Levels of Evolution left in different Dissolutions of the Highest Centres.*—I particularly wish to urge that in post-epileptic insanities the dissolution is local in the sense that it preponderates in the highest centres of one half of the brain. If so, it follows that the level of evolution remaining is a lower one in one half of the brain, and a very high collateral one in the other. This is important with regard to post-epileptic cases in which the dissolution is not so deep as in coma, cases of post-epileptic unconsciousness with mania for example ; the mania is the outcome of activities on the levels of evolution remaining. And I submit that the seeming exceptions to the law of dissolution which some of these cases present (the coexistence of great negative affection of consciousness with highly special actions) is accounted for by the hypothesis of there being deep dissolution in one hemisphere, and a high level of evolution in the other. If general paralysis be a dissolution beginning in the highest motor centres, ultimately on both halves of the brain, the positive mental symptoms arise during activities of the intact posterior lobes, posterior level of evolution, and of what is left intact of the anterior. It is only in such dissolutions as that produced by alcohol that we can expect anything like a uniform dissolution, and simply a lower level of evolution. But even here no doubt some divisions of the highest centres will begin to "give out" before others, and thus, early in the poisoning by alcohol, there will not be an uniform dissolution, and thus not an even lower level of evolution remaining.

We have instanced—it may be taken hypothetically—four local dissolutions and one uniform dissolution of the highest centres. We have implicitly urged that, in each case of insanity, indeed in all nervous diseases, we have a problem in evolution as well as in dissolution. The levels of evolution vary in the different kinds of insanity. Indeed, in healthy states there is a rhythm of evolution and dissolution. But keeping to cases of insanity, I would remark that disease, in the strict sense of pathological process, produces the negative physical change dissolution only, answering to negative affection of consciousness ; disease is not the cause of positive mental symptoms. He who is studying the physical

conditions of positive mental symptoms in any case of insanity is dealing with evolution. The physical process during an illusion is as certainly an evolutionary process as that during normal perception is; the illusion is the insane man's perception, and is part of the mentation going on on the lower levels of evolution remaining (his *then* highest levels), of a nervous system mutilated by disease. The qualifications stated in this section are to be borne in mind when the term insanity is used.

(5) *The Hierarchy of Nervous Centres*.—I am supposing the nervous system to be a sensori-motor mechanism, from bottom to top; that every part of the nervous system represents impressions or movements, or both. (Under the head of movements we place effects produced through motor nerves to glands, and through inhibitory nerves.) The further hypotheses are that the highest divisions of this sensori-motor mechanism, "organ of mind" (1) represent impressions and movements of *all parts* of the body; (2) in most complex, &c., combinations; and (3) triply indirectly. We must now say something of lower centres in order to see how the constitution of the highest centres is, so to speak, achieved.

It is not possible at this stage to do more than state, in incomplete outline, the evolutionary hierarchy of the nervous centres. Qualifications will be given and additions made later. The periphery is the real lowest level; but we shall speak of three levels of central evolution. (1) The lowest level consists of anterior and posterior horns of the spinal cord, and of Clarke's (visceral) column, and Stillings nucleus and of the homologues of these parts higher up. It represents all parts of the body most nearly directly. (It is at once the lowest cerebral and the lowest cerebellar level of central evolution; the periphery being also cerebro-cerebellar, and the lowest level of the whole organism). (2) The middle level consists of Ferrier's motor region, with the ganglia of the corpus striatum, and also of his sensory region. It represents all parts of the body doubly indirectly. (3) The highest level consists of highest motor centres (præ-frontal lobes), and of highest sensory centres (occipital lobes). They represent all parts of the body triply indirectly.* These highest sensori-motor centres make up the "organ of mind" or physical basis of consciousness; they are evolved out of

* My hypothesis is that the middle and highest motor centres are only *chiefly* motor, and that the middle and highest sensory are only *chiefly* sensory.

the middle, as the middle are out of the lowest, and as the lowest are out of the periphery; thus the highest centres re-represent the body—that is, represent it triply indirectly. I wish to bring prominently into notice objections to the view here taken as to the highest sensory and motor centres.

(6) *The Highest Motor and Highest Sensory Centres.*—I have long held the hypothesis that the whole of the anterior lobe is (chiefly) motor. But that the præ-frontal lobes are motor is a doctrine held by few. Ferrier and Gerald Yeo ("Proc. Royal Soc.," January 24th, 1884) have concluded, from experiments on monkeys, that the præ-frontal lobes represent some movements, and significantly these are lateral movements of the eyes and head—the most representative of all movements. But I have now to say that whilst 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.

Ferrier combats the view I take in the second edition of his "Functions of the Brain," p. 460 and seq. For the contrary opinions of such a man I have a most profound respect. I do not suppose that there is such a decided division between middle and highest centres as there is between lowest and middle. Indeed, Ferrier has found that there is some wasting after ablation of the præ-frontal regions in monkeys descending to the medulla oblongata, but no further. This may tell in favour of his opinion that there is no division into middle and highest motor centres, or may show only that the division is not absolute. It may shew that some direct connexions exist between the highest centres and some of the lowest centres, without the intermediation of the middle.*

I have long held that the posterior part of the brain is (chiefly) sensory, and have for some years called the occipital lobes the highest sensory centres. But now I have mis-

* Some time ago ("Med. Times and Gazette," March 1, 1879) I suggested that "there are movements, organic and animal, concerned during emotional states, which will have an exceedingly wide representation in the cerebrum, and probably more directly in the highest centres than any other class of movements."

givings as to the occipital lobes being the highest sensory centres, consequent on reading Gowers' masterly work, "Diseases of the Brain," especially pp. 22 and 174. However, I shall have little, if anything, directly to say of the cerebral sensory centres. The morphological position of these centres is a very important matter, but does not concern us much for the things to be discussed in this paper.

(7) *The Process of Evolution*.—Each of the levels is universally representing, and thus we have yet to state the evolutionary differences between them beyond that of degrees of indirectness of representation. I do little more than give the formula of process of evolution. "Following out hints furnished by Linnæus, K. F. Wolff, Goethe, and Schelling, this great embryologist [Von Baer] announced in 1829 his great discovery, that the progressive change from homogeneity to heterogeneity is the change in which organic evolution essentially consists" ("Fiske's Cosmic Philosophy," Vol. I., p. 342). The modern doctrine of evolution goes further than this. There are, according to Spencer, other factors in evolution. I state four factors. Illustrating by movements and with reference to the three ranks of motor centres, we say that there is from lowest to highest centres, (1) increasing complexity (differentiation), representation of a greater number of *different* movements; (2) increasing definiteness (specialization), representation of movements for more particular duties; (3) increasing integration, representation of movements of wider ranges of the body in each part of the centres*; (4) the higher the centres the more numerous the interconnexions of their units (co-operation).†

* The formula of evolution states a doctrine of localization, and one very different from the current one. Integration, a very important factor, is ignored by the current doctrine. It is an exceedingly important factor. It is admirably and very simply stated by Dr. Mercier, who, in an article to be referred to again presently, p. 480, writes: "Such centres [lowest centres] represent a limited part of the body very strongly; they represent little else, and that little but feebly. But in the highest regions each centre represents a large part of the organism preponderatingly, a still larger part in less degree, and the whole of the organism in some degree. And in the intermediate centres the representation is intermediate in character, a larger or smaller area being preponderatingly represented, and the halo of partial representation being larger or smaller, while the intensity of representation is less or more, according as the centre is more or less elevated in the hierarchy of the nervous system."

† I have used terms more familiar to medical men than those Spencer uses. For this change, of course, Spencer is not answerable, nor must he be held responsible for the correctness of my statements and applications of his formula of evolution. I should consider it a great calamity, were any crudities of mine imputed to a man to whom I feel profoundly indebted. It is for this reason that I do not quote Spencer in other parts of this article, although I believe it to be pervaded by Spencerian ideas.

Thus, to recapitulate, the highest centres are the most (1) complex, (2) most special, (3) most integrated sensori-motor centres, with (4) most numerous interconnexions. They represent all parts of the body in the ways mentioned, and represent them triply indirectly. They are the anatomical substrata of consciousness. I say *anatomical*. The anatomy of nervous centres is not to be confounded with their morphology. Indeed some parts of the cord, and of the bulb too, do not belong to the lowest level of evolution. The patient who has "idiopathic" lateral sclerosis has "disease of the cord," but not of the lowest level of evolution, although of part of a plexus or strand of fibres between motor centres on the lowest and on the middle level.

It will have been noticed that the evolutionary scheme of centres ignores morphological divisions. Any centre, bulbar or spinal, which represents a part of the body most nearly directly and in simplest ways is a lowest centre. Lowest centre is a proper name, and hence we may speak of two lowest centres. As said, Section 3, ophthalmoplegia externa (wasting of cells of some lowest centres in the floor of the aqueduct of Sylvius) is a lowest level paralysis as much as the ordinary type of progressive muscular atrophy is.

To give an account of the anatomy of any centre is to give an account of the parts of the body it represents, and of the ways and of the degree of indirectness in which it represents them. The anatomy of the highest centres or "organ of mind" is given, although most generally, in the recapitulatory statements just made.

(8) *The Dynamics of the Chain of Centres.*—A way of speaking of degrees of indirectness of representation (Section 5) more fully, is to say that nervous evolution does not imply insensible gradations, but occasional stoppages, which are re-beginnings. For example, the lowest motor centres are connected by a plexus or strand of fibres, pyramidal tract, with the middle centres, which are the lowest centres, suddenly "raised to a much higher power." Hence centres are not only "reservoirs of energy," but also "resisting positions." Ignoring the resisting side of the function of centres prevents our seeing clearly the differences between the physical processes during faint and during vivid states of consciousness in health and in disease. The highest sensory centres are triply detached from (protected from) the sensory periphery. The muscular periphery is triply detached from (protected from) the highest motor centres. Were it not for

these "protections" there would be no physical basis corresponding to the differences between faint and vivid states of consciousness. Thanks to the "protection," activities of the highest centres can go on uninterfered with by the environment, and without producing reactions upon it; psychically there can arise trains of thought, faint states of consciousness, independent of present experiences. There is internal evolution. For these and other purposes we should note that the evolutionary ascent, from lowest to highest sensory centres, is a passage, not only from the simple, &c., to the complex, &c., but from the most towards the least organized—from centres easily transmitting accustomed stimuli and resisting novel stimuli, up to centres which have to be forced into activity. The peripheral impact being strong enough, all sensory centres are overcome in order, there is a multiplication of energy liberations upwards, and finally great irradiation in the highest sensory centres and "survival of the fittest" states. Thus from a very local peripheral change we have ultimately changes induced in many nerve units of the highest centres, each of which represents the whole organism, although they represent by far the most the part of the periphery engaged. Consequent on the strong discharges of the highest sensory centres the connected highest motor centres are next put in great activity.

The passage next is not only from the most complex motor nervous arrangements to the most simple, but from the least organized to the most organized, from centres capable of being forced into new kinds of activity to centres acting in ways they have been trained to act in, and resisting new ways of acting; the stage of "effecting of the possible." Here is a narrowing of energy liberations downwards, so that from energizing of motor nervous arrangements of the highest centres representing the whole organism, there results movement of but the part most specially represented in those motor nervous arrangements.

The resistance offered by middle to highest centres is important with regard to the differences between *les petits maux* and *les grands maux*, and with regard to differences in degrees of post-epileptic states. Above all, it is important with regard to differences in the physical conditions during faint and vivid states of (object) consciousness, ideation and perception for example. In speaking of resistances by centres we suppose there to be degrees of resistance, the smaller cells of the centres resisting least.

(9) *Recapitulation and Recommencement.*—The highest centres are, we repeat, nothing else than centres of universal and most complex, &c., representation, or what is equivalent of universal and most complex, &c., co-ordination. There is nothing else for them to represent than impressions and movements. Using old-fashioned language they are potentially the whole organism; the whole organism is “potentially present” in them. They are the unifying centres of the whole organism, and thus the centres whereby the organism *as a whole* is adjusted to the environment. Anticipating, they are, although the most complex, &c., the least organized, the ever organizing, and thus the centres whereby new adjustments of the organism, as a whole, to the environment are possible, that is, the centres in which evolution is most actively going on. Correspondingly they are the least automatic, or most imperfectly reflex, centres.

I have long since come to the conclusion above stated, that the cerebrum (I now say highest centres of the cerebral system) is universally representing. Nearly eighteen years ago I wrote: “We have now, then, to add to the constitution of the units of the cerebrum nerve fibres to the heart vessels and viscera, or rather possibly to regions, of the sympathetic system from which these parts are supplied. The inference we have now arrived at is that the units of the cerebral hemisphere (in the region of the corpus striatum, at least) represent potentially the whole processes of the body” (“Medical Mirror,” Oct., 1869). 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). These are crude statements, but I have since given, I hope, clearer accounts of the hypothesis.

In “Brain,” January, 1887, there appears an article by Dr. Mercier on “Coma,” already quoted from, which deals with insanity realistically and in a very masterly manner. It is a great satisfaction to me to find that Dr. Mercier agrees with me in many of the opinions I have formed on insanity, considered as dissolution beginning in the highest centres

of the cerebral system. These centres he agrees with me in thinking to be sensori-motor, universally representing and most complex. When dealing with the physical condition in coma, Dr. Mercier writes, "Thus we arrive at this most important conclusion: that the highest nervous processes, which form the substrata of the most elaborate mental operations, represent at the same time not only the most elaborate forms of conduct and muscular movements, but also *every part of the organism* (italics in orig.) in some degree." Ribot, in his remarkable and most valuable work on "Personality," writes, "Nous pourrions dire que la conche corticale représente toutes les formes de l'activité nerveuse; viscérale, musculaire, tactile, visuelle, significatrice." In another part of his book Ribot writes, "Le moi est une co-ordination." The assertion I make is that the *physical basis* of the Ego represents—that is, that the highest centres represent—or co-ordinates the whole organism in most complex, &c., ways. Just as the consciousness of the moment is, or stands for, the whole person psychical, so the correlative activities are of nervous arrangements, representing the whole person physical.* In this connexion I would refer to a very able paper ("On the Pathology of Mania") by Dr. Wiglesworth, "Journ. Mental Science," January, 1884.

(10) *Representation and Co-ordination—Disorders of Co-ordination with Negative Lesions.*—A statement made (Section 9) that representation and co-ordination are the same thing, is contrary to current opinion. Although co-ordination or representation is always sensori-motor, I shall arbitrarily limit present illustration to motor centres. I should say that the highest motor centres (præ-frontal lobes) co-ordinate movements represented in the middle centres (Rolandic region) only in the sense that the former represent over again in more complex, &c., ways, the movements represented by the latter; just as the latter represent over again and in more complex, &c., ways, what the lowest motor centres have represented in less complex ways, and just as these lowest centres represent the muscles in least complex ways. In short, all centres of all ranks are at once co-ordinating and representing. I have a particular reason for this recapitulation. I assert that negative lesion of

* This sentence implies more than has been expressly stated, viz., that each unit of the highest centres is a miniature highest centre, that is, represents in some degree the whole organism (Factor Integration), no two units representing it in just the same way (Factor Differentiation).

any centre never produces "disorder of co-ordination;" it produces paralysis, sensory or motory, or both, and nothing more. The doctrine of nervous evolution will not be understood unless it be seen clearly that centres do not represent muscles but movements of muscles. Thus, referring to the illustration given (Section 3), there is in progressive muscular atrophy loss of simplest movements (in this case, it is true, nearly approaching loss of muscles), in cortical monoplegias there is loss of more complex movements, and in cases of general paralysis there is loss of most complex movements. Motor paralysis from negative lesion of any motor centre is always loss of movements.

There is something more than paralysis in inco-ordination from negative lesions, but this something more is not produced by the negative lesion, not by disease in the proper sense of pathological change. When we speak of evolution it is understood (Section 4) that there is evolution with dissolution. Dealing only with dissolution from disease, we say that in the cases of inco-ordination from negative lesion of lowest motor centres, for example "professional cramps," there is loss of some most special movements (dissolution) of certain muscles, and from over-activity of levels of evolution left, there is forcing of other more general movements of those muscles. There is on a small scale what there is on a large scale in insanity (Section 4). In fact, the formula of all inco-ordinations due to negative lesions, from the duplex symptomatology of cases of paralysis of ocular muscles up to the duplex symptomatology of cases of post-epileptic unconsciousness with mania (the physical condition), is that there is loss of some (most special) movements with forcing of other (more general) movements. This is assuming that there is paralysis from the negative state of the highest centres which is implied by the negative affection of consciousness.

(11) *Consciousness and the Physiology of the Highest Centres.*—So far we have said nothing, except incidentally, of consciousness. To the assertion that the highest centres are only the latest developed and most elaborate part of a sensori-motor mechanism, it may be rejoined that "they are for mind." So we have taken them to be *in the sense that they are the physical basis of mind*. But they are "for body" too; strictly they are for nothing else—for nothing else than for co-ordinating or representing the different parts of the body in relation to the whole in most complex, &c., ways.

It may be said that "consciousness is a function of the brain" (highest cerebral centres). This I deny. Function is a physiological term; it has to do with the dynamics of the nervous system, with things physical only. It has to do with storage of energy (the taking in of materials having potential energy),* with nervous discharges (or liberations of energy) by nerve cells; with the rates of the liberations, the resistances encountered, and the degrees of those resistances. The "organ of mind" is only the most complex, &c., part of what is anatomically a sensori-motor machine, and there is nothing going on in it, other than nervous discharges, overcoming lines of resistance in order, from least towards most; there is no interference by volition, emotion, &c. We cannot take a too brutally materialistic view of the "organ of mind," but in order to do so we must not take a materialistic view of mind.

(12) *Several Doctrines as to the Relation of Consciousness to Activities of the Highest Centres.*—I am not competent to discuss the metaphysical question of the *nature* of the relation of mind to nervous activities. There are three doctrines (1) That mind acts through the nervous system (through highest centres first); here an immaterial agency is supposed to produce physical effects; (2) that activities of the highest centres and mental states are one and the same thing, or are different sides of one thing. A third doctrine, (3) one I have adopted, is that (a) states of consciousness (or synonymously states of mind) are utterly different from nervous states of the highest centres; (b) the two things occur together, for every mental state there being a correlative nervous state; (c) although the two things occur in parallelism, there is no interference of one with the other. Hence we do not say that psychical states are functions of the brain (highest centres), but simply that they occur during the functioning of the brain. Thus in the case of visual perception, arbitrarily simplifying the process, there is an unbroken physical circuit, complete reflex action, from sensory periphery ultimately 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 (sensori-motor elements of highest centres)—so to speak, it "stands outside" these links.

(13) *The Doctrine of Concomitance.*—It seems to me that

* Perhaps this storage is better described as being part of the nutritive process.

the third doctrine, that of concomitance, is at any rate convenient in the study of nervous diseases. A critic of my Croonian Lectures, who in all other respects dealt with my opinions very good-naturedly, says that I state this doctrine in order to evade the charge of materialism. It, or an essentially similar doctrine is held, so far as I can make out, by Hamilton, J. S. Mill, Clifford, Spencer, Max Müller, Bain, Huxley, Du Bois Raymond, Laycock, Tyndall and Herman. The critic referred to says that the doctrine of concomitance is Leibniz's "two clock theory." It may be; it matters nothing for medical purposes whether it is or is not. The evolutionist does not, however, invoke supernatural agency. As Fiske says, "The assertion of the evolutionist is purely historical in its import, and includes no hypothesis whatever as to the ultimate origin of consciousness; least of all is it intended to imply that consciousness was evolved from matter." ("Darwinism and other Essays," p. 67.)

The doctrine of concomitance will seem unsatisfactory to those who seek an explanation of mental states. But no explanation is intended in any part of this paper. Supposing the account given of the constitution of the "*organ of mind*" to be more thorough and quite accurate, it would be no explanation of the mental states correlative with its activity. The second doctrine seems to give an explanation, or rather complacently assumes that there is nothing to explain. It, like the two others, is a metaphysical doctrine, although I imagine some holders of it would consider it a very realistic and most practical statement of the facts. To merely solidify the mind into a brain, is to make short work of a difficult question. And if we go on talking of the "brain mind" essentially in the same way as the popular psychologist does of the mind—"emotional centres," "volition producing movements," &c.—we help nothing in a scientific study. Further, supposing the doctrine of crude materialism be true, it does not go far enough. For to give a correct materialistic account of mind—I mean, granting for the moment that such an account can be given—is not to give an anatomical account of brain, which (Section 7) is to show what parts of the body it represents, and the ways in which it represents them.* The first doctrine seems to me to be the least worthy of attention.

* For many medical purposes I could adopt the second doctrine if it were formulated that the brain had two functions—one mental, and the other that of co-ordinating parts of the body.

To put the matter in another way, let it be granted for the sake of argument that the separation into states of the highest centres, and what we called the utterly different and yet concomitant states of consciousness, is known to be erroneous, and that the doctrine (2) is ascertained to be the true one. I then ask that the doctrine of concomitance be provisionally accepted as an artifice, in order that we may study the most complex diseases of the nervous system more easily. There can be no difficulty in understanding the *statement*. It is as easy to understand the *statement* that states of consciousness simply occur *during* activities of the highest parts of the nervous system, as it is to understand the *statement* that states of consciousness occur *from* such activities. It makes it neither more nor less difficult that the activities are of centres which represent or co-ordinate impressions and movements in the ways several times mentioned.

Our concern as medical men is with the body. If there be such a thing as disease of the mind, we can do nothing for it. Negative and positive mental symptoms are for us only signs of what is not going on, or of what is going on wrong, in the highest sensori-motor centres.

(14) *The Range of Concomitance*.—What is the range of concomitance? For my part I think the whole body is “the organ of mind,” as I have in effect asserted (Section 8) when speaking of the dynamics of the chain of centres. I shall, however, continue to speak of the highest centres as being the “organ of mind.” Here the question recurs: “How far down” in the highest centres is there consciousness attending nervous activities?

A distinction is made by many between mind and consciousness.* I suppose they would say that consciousness shows activities of the highest and mind activities of the lower nervous arrangements of the highest centres. I take consciousness and mind to be synonymous terms (Section 1); if all consciousness is lost all mind is lost (Section 2). Unconscious states of mind are sometimes spoken of, which seems to me to involve a contradiction. That there may be activities of lower nervous arrangements of the highest centres, which have no attendant psychical states, and which yet lead to next activities of the very highest nervous arrangements of those centres whose activities have attendant psychical states, I can easily understand. But

* I admit the distinction into Subject and Object consciousness, and also that into faint and vivid states of consciousness.

these prior activities are states of the nervous system, not any sort of states of mind.

There is one way in which this question directly concerns us. After some epileptic fits the patient is "unconscious," and acts elaborately. Is he really void of all consciousness? Some might say that the fact of his remembering nothing of his actions on recovery (this is the rule) is proof of entire absence of consciousness; others would say that the elaborateness and the purposive seemingness of the patient's actions show that he had some consciousness remaining. Each opinion has consequences, as we shall see. To say that the patient had unconscious or latent states of mind does not, I think help us. As evolution progresses, consciousness is, so to speak, "raised higher;" it may be that in dissolution the activities on the lower level of evolution have attendant states of consciousness which in normal conditions they had not, or that their normal slight states of consciousness become more vivid.

(15) *Consequences of Accepting the Doctrine of Concomitance.*—Those who accept the doctrine of concomitance do not believe that sensations, volitions, ideas, and emotions produce movements or any other physical states. These expressions imply disbelief in the doctrine of conservation of energy*; movements always arise from liberations of energy in the outer world, and it would be marvellous if there were an exception in our brains, marvellous if, for example, The Will, an immaterial agency, interfered in the activities of nervous arrangements of the highest centres.† They would not say that an hysterical woman did not do this or that be-

* It may, however, be said that it has not been shown that the principle of conservation of energy does apply in physiology. On this matter I quote from Daniel's "Principles of Physics," p. 45: "There is one case in which the principle of the conservation of energy is not as yet definitely established. This is in the domain of Physiology, but the words of Clark Maxwell may, in this connection, be quoted: 'It would be rash to assert that any experiments on living beings have, as yet, been conducted with such precision as to account for every foot pound of work done by an animal in terms of the diminution of the intrinsic energy of the body and its contents; but the principle of Conservation of Energy has acquired so much scientific weight during the last twenty years, that no physiologist would feel any confidence in an experiment which showed a considerable difference between the work done by an animal and the balance of the amount of Energy recovered and spent.'"—"Nature," Vol. xix., p. 142.

† I mean that they would not in scientific exposition. I no more object to the statement that "fright makes the heart beat," or that "mind influences the body" at a clinical conference, than I do to the statement that the "sun rises in the east" in ordinary talk. But the mind does not influence the body, although the highest centres affect the rest of the body, and the sun does not rise in the east.

cause 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 was unconscious. On the contrary, they would give, or try to find, materialistic explanations of physical inabilities. They would not use the term sensation convertibly with active states of any sensory elements. They would avoid such expressions as "Physiology of the Mind," "Psychology of the Nervous System," and "Dissolution of the Mind." They would not use such compounds of (1) psychological, and (2) anatomico-physiological terms, as (1) "ideo- (2) motor," (1) "voluntary (2) movement" " (1) ideas of (2) movements," (1) "psycho- (2) motor," &c. They would not speak of " (1) voluntary (2) centres," (1) "emotional (2) centres." They would not use "most voluntary" as the proper opposite of "most automatic." Automatism is a purely physical thing. There are degrees from most automatic, not up to the most voluntary or to volition, but to least automatic. During activities of the least automatic centres (highest centres), Will and other elements or states of (object) consciousness arise. They would not in scientific exposition make piebald classifications of symptoms, *e.g.*, *sensory*, *motor*, emotional, and intellectual. The two words italicised are names of physical states; the other two of psychical states. Such classifications, perhaps allowable clinically, are, for scientific purposes, as unjustifiable as a classification of plants into endogens, graminaceæ, kitchen herbs, ornamental shrubs and potatoes, would be. They would not compare, nor even contrast, loss of consciousness in cases of disease of the highest centres with paralysis from disease of any lower centres.

The term subjective is used in different senses in medical writings. It is sometimes used for psychical states in contrast to the correlative nervous states, which latter are then called objective; sometimes for faint states of consciousness, as in ideation, in contrast to vivid states of consciousness, as in perception, which are then called objective; sometimes very crudely, for mind and brain together in contrast to "real things," that is, objects in themselves coloured, shaped, &c., which are then called objective.

(16) *Recapitulation*.—I speak now in recapitulation both of the sensori-motor mechanism and of states of consciousness. The assertion is not simply that states of consciousness attend activities of nervous arrangements. Nor is it enough to say that they attend activities of highest nervous

arrangements of the highest centres unless it be understood that these nervous arrangements represent, or co-ordinate, parts of the body in most complex, &c., ways. A morphological account of the physical bases of psychical states does not suffice; we must give an anatomical account. Whilst a man is thinking, or even dreaming, of a brick, he is having a purely psychical state; the correlative physical state is slight discharge of some complex, &c., nervous arrangements of his highest centres. So far, the statement as to the physical process is only morphologico-physiological. But we go on to add *representing parts of his body*—certain retinal impressions and particular ocular movements—that is, an anatomico-physiological account of the physical process. So far for the faint state of consciousness, thinking of the brick (ideation); the physical process is confined to the highest centres. In perception, seeing the brick vivid state of consciousness (see Section 8), the highest centres are acted on from the periphery, and react upon it; here at any rate is sensori-motor action, exceedingly compound reflex action.* Similarly, *mutatis mutandis*, for vivid and faint mental states of other kinds and for the anatomy of their physical bases. Repeating, in effect, a former statement (Section 1), the epileptic convulsion is nothing other than a sudden, excessive and nearly simultaneous development of the motor element in the anatomical substrata of crowds of psychical states (in their totality, states of consciousness), with next development of less evolved motor elements of the middle and lowest centres.

I will now try to show the bearing of the remarks in Sections 14, 15 and 16 by a particular case.

(17) *Analysis of the Symptomatology of Slight Fits of Epilepsy.*—A slight fit (*le petit mal*) of epilepsy proper is owing to a slighter discharge beginning in some part of the highest centres than that which produces the severe fit (Section 1). The discharge being resisted by the middle motor centres, produces slight peripheral effects, but irradiating widely in the highest centres, there may be seemingly absolute loss of consciousness. Apart from the particulars of this speculation, let us consider the differences in what we put together clinically “as symptoms of epilepsy.” We shall take symp-

* The illustrations are arbitrarily simplified. The nervous arrangements discharged during any mental process no doubt represent the whole body (Integration), although some part of it most (specialization); during visual perception those discharged represent most especially the retinal and ocular parts of the body.

toms of slight fits from cases of several patients. I wish to suggest that the proper analysis of this complex symptomatology is impossible unless, among other things, we distinguish between the psychical and the physical. We have also to note degrees of positive and superpositive states of consciousness in these cases from the crudest to the most elaborate, and to consider the physical conditions of them. We have also to consider separately negative affections of consciousness and degrees of them. We have also to distinguish between physical conditions, especially between convulsions and movements ordinarily so-called. In things so complex as epilepsy and insanity, generalizations are worthless without prior analysis. As was shown, Section 1, the epileptic paroxysm is an exceedingly complex thing.

(1) There is sometimes a "warning" of crude sensation, *e.g.*, a stench comes into the nose. As the term sensation tells us, this is a mental state, it is superpositive. It is a very crude and excessive state, and implies the correlative physical condition of sudden, &c., discharge of many central olfactory elements at once, and is our clue to the seat of the "discharging lesion." (2) There is the emotion of fear. (I do not mean a fear of the fit, but "fear which comes by itself.") This is a very complex psychical state, and, I submit, does not occur during sudden, &c., discharges, but arises during slight discharges of very complex nervous arrangements representing parts of the body, especially organic parts, concerned in the manifestations of fear.* (3) There is sometimes the "dreamy state," so-called "intellectual aura;" for example, there rises a feeling "of being somewhere else." This is an exceedingly complex mental state, and cannot, I submit, arise during discharges at all comparable in degree with those which produce convulsions. Consider how vastly it differs in degree of elaborateness from a crude sensation, the physical condition for which crude sensation is comparable to the sudden, &c., discharge of motor elements from which convulsion results. So far we have spoken of positive and superpositive states of consciousness, urging that there are great differences in their degrees of elaborateness, and alluding to their physical correlatives. There are negative states of consciousness.

There is very often a stage of (4) defect of consciousness

* My belief is that what are called the manifestations of fear are really after-effects of a discharge. Fear is anger broken down, and is antithetical to anger in that sense.

before what we call (5) loss of consciousness. These negative affections of consciousness occur during the sudden, &c., discharge; for whilst consciousness arises during slight sequent discharges, it ceases during sudden, &c., discharges of many nervous arrangements at once.*

We have (6) convulsions of the eyes, face, hands, and other parts; these do arise from sudden excessive discharges developing many movements of the several parts simultaneously. I submit that they occur especially from discharges beginning in motor elements entering into the anatomical substrata of visual ideas, of words, of tactual ideas, and of other psychical states (Section 16), and from next discharges of connected motor elements of middle and lowest centres. (7) Pallor of the face, arrest of heart, flow of saliva, passage of fæces and urine, are results of sudden, &c., discharges beginning in motor elements entering into the anatomical substrata of emotions and other psychical states. Some of these, however—*e.g.*, the passage of fæces—are the indirect results of such discharges—are owing to permitted over-activity after exhaustion of inhibitory nervous arrangements by the epileptic discharge.

Convulsion is the “running up” of very many movements into a fight. But (8) there are sometimes in the slight epileptic paroxysm movements properly so-called, *e.g.*, clutching at the throat, rubbing one hand with the other, chewing and tasting movements. These arise, I submit, as an indirect result of comparatively slight epileptic discharges of sensory elements. Thus the chewing movement (so often associated with the “dreamy state”) is, I submit, the indirect result of an epileptic discharge of gustatory elements (Ferrier finds that faradising a monkey’s gustatory centre produces such movements). Now for the post-paroxysmal state.

After a slight paroxysm of *le petit mal*, in many cases the patient may be (9) simply confused for a short time, that is defectively conscious; physically there is exhaustion of very few elements of his highest centres, and correspondingly, I submit, he is slightly paralysed consequent on this exhaustion. For it is of the motor and sensory elements in the physical bases of mental states, and of connected elements of lower centres. The condition is, however, described

* When there is the “dreamy state” there is double consciousness (“mental diplopia”), there being remains of consciousness as to present surroundings (remains of object consciousness), and increase of consciousness as to some former surroundings (increase of subject consciousness).

popularly as "prostration," &c. After a severer attack of *le petit mal* there (10) remains what is called (Section 14) "loss" of consciousness, implying, it is suggested, still deeper exhaustion, and, correspondingly, more paralysis. But often there is (11) with the "unconsciousness" a concerted series of elaborate movements of all parts of the body (mania for one example) which are the physical counterparts of what are psychically actions or conduct. Now, contrary to some physicians, I submit that these are not the result of anything like an epileptic discharge, but that they arise during activities on the lower level of evolution remaining (Section 4). The prior epileptic discharge has left exhaustion of, say, the highest "layer" of the highest centres (dissolution); the series of movements result from activity but super-normal of the second, the no longer controlled layer. Here is a phenomenon of the same order as increased rate of cardiac action after section of the vagus.

(18) *Suggested Scheme of Work*.—Before going further I make the following statements, partly in recapitulation and partly to give an outline of future exposition. We have to show how the following superficially different sets of phenomena occur from disease of the "organ of mind," and how they are explicable on the principle of dissolution.

(I) *From* sudden, rapid, and excessive discharges beginning in some part of the "organ of mind" we have universal or widespread convulsion or its equivalents. Although consciousness arises during slight sequent discharges of nervous arrangements of the highest centres, it ceases during the sudden, &c., discharges thereof.

(II) After the fit there is often insanity. We make three degrees of post-epileptic insanity. There are correspondingly three depths of exhaustion (dissolution) effected by the discharge in the prior paroxysm, each depth being proportionate to the severity of the prior discharge. To these negative physical states the negative mental symptoms, defects of consciousness, marked (a) correspond. There are correspondingly three shallows of evolution; the positive mental symptoms, the patient's mentation, marked (b) correspond to what are physically activities on these lower levels.

(1) After, or in, a slight fit, there is (a) defect of consciousness as to present surroundings with (b) increase of consciousness ("dreamy state") as to some former surroundings. (See Section 17.) These are selected cases of *le petit mal*, and the nature of the physical condition for the symptoms is dis-

puted, it being held by some that the two opposite mental states occur during a slight epileptic paroxysm. Hence, beyond now stating (1) as provisionally a first depth of dissolution, I shall say no more of it. (2) After a severer fit, or on partial recovery or re-evolution from the effects of a severest one, there is (a) so-called (Section 14) "loss" of consciousness with (b) actions (post-epileptic "unconsciousness" with mania for one example). Here is a second depth of dissolution with a less high level of evolution remaining. (There are sub-degrees of this degree. There are, speaking only of the positive element, degrees from most elaborate and highly special actions to the simple and very general actions of sprawling on the floor.) (3) After a severest fit there is (a) coma. Here there is no positive mental state according to current opinion; there is acute dementia. There is a lower level of evolution; there are, as outcomes of its activity, of course, certain "vital" movements (circulatory and respiratory), or the patient's dissolution would be total. But these "vital" movements being physical things are not comparable and contrastable with (b) in (1) and (2). Here is a third depth of dissolution with a very shallow level of evolution remaining.

Everybody regards No. 2 as insanity (middle depth of dissolution with middle level of evolution remaining), but scarcely anyone takes No. 1 and No. 3 to be insanity. Sometimes (2) occurs on partial recovery from (3); even then, although 2 is called insanity, 3 is not. My contention is that from a scientific, I do not say from a clinical standpoint, 1, 2, and 3 are insanities; 3 is temporary acute dementia. That each is a departure from the patient's normal mental state is enough for us as evolutionists to whom all three are insanities; for us as clinicians, 1 and 2 do not approach standard clinical types of insanity, and are thus, for the clinician, not insanities.

(III) These degrees of insanity have to be compared and contrasted with three degrees of the physiological insanity of sleep:—(1) Sleep with dreams; (2) Deeper sleep with actions (somnambulism); (3) Deep so-called dreamless sleep. Also with three degrees of drunkenness (Mercier makes four). They have to be compared and contrasted with degrees of insanity in acute non-cerebral disease (pneumonia for example); with degrees of insanity from poisoning with belladonna, cannabis indica, &c. Finally, they have to be compared and contrasted with degrees of chronic cases of insanity ordinarily so-called. (As before said, there are

different kinds of insanities, physically dissolutions of different parts of the highest centres.) Besides this kind of comparative study, there is another far more important to the evolutionist.

(IV) Insanities* considered as diseases of the highest centres have to be compared and contrasted with diseases of middle and lowest centres. To this end we have to find the physical condition correlative with the insanities.

(1) The assertion is that negative affection of consciousness, both in the acute transitory insanities spoken of in (II) and the acute and the persisting insanities spoken of in (III), implies paralysis, the paralysis being proportionate to the degree of negative affection of consciousness. On this basis we may compare and contrast not negative affection of consciousness, but paralysis from negative lesions of the highest centres, *which the negative affection of consciousness implies*, with paralysis from negative lesions of middle and lowest centres. To give an illustration, some of the statements being hypothetical: progressive muscular atrophy, paralysis agitans, and general paralysis of the insane are alike in being owing to wasting of cells in the order of their size from smallest towards largest; they are different in that the wasting occurs respectively on the lowest, middle, and highest levels of motor evolution; there is loss of simplest, of complex, and of most complex movements.

(2) Now for positive mental symptoms. These make up, or are to us the present signs of, the patient's mentation or consciousness, and are the lower homologues of his normal mentation or consciousness. We have to try to show how sensori-motor activities—activities of most complex, &c., sensori-motor nervous arrangements, those of the highest centres—are correlative with states of consciousness. To do this we shall accept the artificial analysis of (object) consciousness (we neglect for the moment subject consciousness), into Will, Memory, Reason, and Emotion, and then try to show the anatomy of the physical bases of each—that is, what parts of the body the physical bases (sensori-motor nervous arrangements) of each represent most specially.

In this attempt we must have constant reference to lower centres out of which the highest are evolved. The following is an imperfect sketch, among other things, ignoring In-

* As remarked when speaking of different varieties of epilepsies, of epileptiform seizures, and of bulbar, &c., fits, there are fits from discharges of different levels of evolution. These have to be compared and contrasted, and also the paralyses after fits of each kind.

tegration: What on the lowest level are (1) centres for simplest movements of the limbs become evolved in the highest centres into the physical bases of volition; what on the lowest level (2) are centres for simple reflex actions of eyes and hands are evolved in the highest centres into the physical bases of visual and tactual ideas; what on the lowest level are (3) centres for movements of the tongue, palate, lips, &c., as concerned in eating, swallowing, &c., are in the highest centres evolved into the physical bases of words, symbols serving us during abstract reasoning. (4) What on the lowest level are centres representing the circulatory, respiratory and digestive movements are evolved in the highest centres into the physical bases of emotions. So to speak, the lowest level does menial work; the highest level, evolved out of it, becomes in great degree independent of it and is the anatomical basis of mind.

Negative affections of consciousness are supposed to imply paralysis consequent on loss of the motor (or sensory) elements in the most complex of all sensori-motor nervous arrangements, those entering into the physical bases of the four "faculties" (really four different aspects of object-consciousness) (dissolution). The positive mental symptoms are supposed to be the lower homologues of the patient's normal Will, Memory, Reason, and Emotion (object-consciousness). They are the mentation going on on the lower, but then highest, level of evolution, &c., and imply slight sequent activities of less complex, &c., sensori-motor nervous arrangements representing parts of the body, than those lost.
