Remarks on evolution and dissolution of the nervous system. No. 1 / by J. Hughlings Jackson.

REMARKS ON

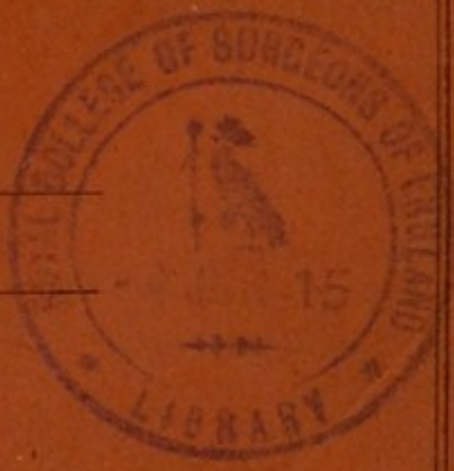
EVOLUTION AND DISSOLUTION

OF THE

NERVOUS SYSTEM.

BY

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



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REMARKS ON

Evolution and Dissolution of the Nervous System.

Preliminary.

By regarding Nervous Diseases as Dissolutions of different parts of one Evolutionary System, we shall, I hope, be able to make a Comparative Study of all of them; from the most simple cases, such as paralysis of an external rectus, up to the most complex of all—cases of insanity.(1) This comparative study cannot be properly entered upon unless we distinguish psychical states from their correlative physical states. Nor can we make a comparative study on the widest scale unless we consider the highest cerebral centres ("organ of mind") to be of the same kind of constitution—sensori-motor—as the lower centres.

I believe that this article is pervaded with Spencerian ideas. I should make more detailed acknowledgments were it not for the fear that I might be attributing crudities of my own to this distinguished man. (*See a footnote to Section XVI.*)

Section I. *Abrupt Beginning—Perception and Ideation.*—By perception I mean simply what is given in such a proposition as "I see a brick," and by ideation what is given in such a one as "I think of a brick." My assertion is that both the "seeing" and the "thinking of" are states of Object Consciousness, that they are but different (compound) degrees of Objectivisation.

(1) I have briefly spoken of the comparison and contrast of these two in the concluding part of an address before the Medical Society (*British Medical Journal* and *Lancet*, October 22nd, 1887.)

SECTION II. *"Breaking up" and "Making up" of States of Object Consciousness.*—It is more correct to say that Ideation or Perception is an element in a state of object consciousness, than to say that either is by itself a state of object consciousness. A state of object consciousness is a thing to the different aspects of which we give the names Will, Memory, Reason, and Emotion. In other words, there are not two things—(1) Object consciousness, and also (2) Will, Memory, Reason, and Emotion. The Will, Memory, Reason, and Emotion of the moment may be said to make up the object consciousness of the moment.

But this is not the real truth of the matter. There is no such "making up." On the contrary, there is, by speaking of the four elements, as we called them, a "breaking up" of object consciousness. There are states of object consciousness which we artificially "break up" into the four elements ("faculties"). Then at other times by a similar artifice we say that they "make up" object consciousness. Just in the same way, going further in artificial analysis, we "break up" ideas or percepts (or, as I shall say, images), themselves artificially separated elements of object consciousness, into sensations, and at other times we speak of sensations "making up" ideas or percepts. Strictly speaking there are no such things as sensations; there are states of consciousness. Yet the artifice that there are is, for many medical purposes (see further on Crude Sensations)[1] very convenient. In the same way it is often convenient to speak as if a state of object consciousness was made up of the four "faculties," and to deal with each separately. But even under this artifice whenever, to give an example, Will is spoken of *as if* it were a distinct "faculty," and independent of the others, it is to be tacitly taken that there is really a state of Object consciousness in which Will only preponderates. And so, *mutatis mutandis*, for Memory, Reason, and Emotion.

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[1] Crude sensations are such as pains, nausea, and also such as visual, auditory, &c. "projections" at the onset of epileptic fits. The crude sensations at the onset of epileptic fits may be extravagantly, not very extravagantly, described as "parasitical" psychical states. A phosphene produced by pressing on the eyeball is a crude sensation. Using the term "sensation" by artifice, we say that all sensations, both in health and in disease, are objective. When I have a phosphene artificially produced, or have or think of having a pain in a finger, I have objective states, as certainly as I have when I see or think of what we call outer objects.

SECTION III. *Restriction and Extension of the meaning of the term Memory.*—We have taken the element Memory for investigation, and shall continue to speak of the two degrees of it, Ideation and Perception. This is, of course, using the term Memory in a restricted sense in one way, and in a wider sense than is common in another way. In a restricted sense because to remember is "to have again" faintly any element (speaking under the artifice mentioned) of object consciousness which we formerly had vividly. The restriction here is to what we shall call Images, most illustrations being by visual Images. The term Memory is used in a wider sense, because it would not commonly be taken to include Perception as well as Ideation. But I think it will be seen that the wide sense, as I call it, is not really too wide—that at any rate perception is mainly memory. There is nothing paradoxical in this statement, as anyone may see when he recollects that recognition (a synonym of perception) is having relations of likeness and unlikeness; having these relations involves revival of previously acquired states, which is memory.

There is, of course, Subject consciousness with every state of object consciousness. Remembering in the sense of "having again" is "*somebody* having again."

SECTION IV. *The Duality of Consciousness.*—It is impossible to speak of objective states without implying subject consciousness. In every proposition, subject and object consciousness are indicated. In the two stated in Section I, Subject consciousness is symbolised by "I," and Object consciousness by "brick."[1] Each by itself is nothing; each "is only half itself." Some expressions in Popular Psychology give the duality very decidedly. There is the statement "Ideas *come into* consciousness." This is a most explicit acknowledgment of the duality. But it should be "Ideas *come out of* subject consciousness and then constitute object consciousness."

All states of object consciousness "come out of" subject consciousness. It is not meant "come out of" in the sense of being entirely detached from: Objective states, quite detached from subject consciousness would be mental states of nobody's having. It would be absurd to speak of them as being parasitical in us; they might as well be parasitical

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(1) Strictly of course "I" covers both subject and object consciousness. It stands for a person.

in the table I write on. Propositions, say the two in Section I., the first at least, seem to countenance the wrong order. "I see a brick" is, however, to be taken to mean that an image "come out of" ("forced out of") subject consciousness is "projected" (objective state).

The expression "double consciousness" may suggest two separate, independent, similar consciousnesses (two juxtaposed singles), in spite of the remark on subject and object consciousness that "each is only half itself." It is misleading in other ways. Two different states of object consciousness often enough co-exist for one Subject. This having two distinct objective states is quite a different kind of "double consciousness" from that which is meant when subject and object consciousness are spoken of. I shall abandon the term "double consciousness," not because it is incorrect, but because, for the reasons assigned, it is equivocal.(1)

SECTION V. *Various ways in which the terms Subjective and Objective are used in Medical Writings.*—It will have been seen that Subjective and Objective are used in this article as names for different aspects of Mind or, let us say, Mentation, a word introduced by Metcalfe Johnson.(2) I have no authority to define the terms, but it is allowable for me to mention very pointedly some ways in which I do *not* use them :—

(1) Subjective is sometimes used for psychical states in contrast with the correlative nervous states, which

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(1) I quote the following from an old article *On the Scientific and Empirical Investigation of Epilepsies*, *Medical Press and Circular*, March 1, 1876. Being more popularly expressed it may be clearer in some ways. It is, however, to be taken as qualified by what is said in the text of this article. "As repeatedly insisted on, the only difference between seeing the brick and thinking of it is a difference of degree. To perceive a thing is, we repeat, to refer it to the environment ; we do this just as certainly when we think of the brick as when we see it. The former is commonly called an idea, the latter a perception. But an idea [I now say image] is only a faint external perception [percept], and an external perception is only a vivid idea. . . . This difference of mere degrees sinks into insignificance before that difference implied by the rhythm of subject and object consciousness, and illustrated by the unconscious and automatic reproduction of images of objects before that perception which is a conscious and voluntary reproduction of them."

(2) The qualifications to be given to such expressions as Mind (or *the* Mind) *the* environment, *the* time (commonly time) *the* nervous system, &c., are too obvious to need pointing out.

latter are then called objective. Under this use of the terms when I think of a brick (ideation) or see one (perception) I have a faint or a vivid mental state, both of which are subjective. The concomitant states of the nervous system, weak or strong, are objective. I never use the terms in this contrast.

(2) Subjective is sometimes used for faint mental states in contrast with vivid mental states. In this use of the term "thinking of the brick," ideation, is subjective; whilst perception, "seeing the brick," is objective. I have repudiated this contrasted use of the terms in saying that both ideation and perception (or more generally faint and vivid states of object consciousness) are but different degrees of objectivisation.

(3) Subjective is used sometimes for organism, sometimes for mind, and sometimes for brain and mind together (as if they were one thing or "different sides of one thing"). In contrast, the term objective is used for "outer objects," which are in themselves red, square, &c., independently of any percipient. It would seem as if it were held by acceptors of this doctrine that "real," outer objects, in themselves red, &c., "photograph" *their* redness, &c., on us, and thus make us have the sensations red, &c. What the physicist calls red rays, modes of molecular motion, come, somehow, to be in us, not only states of certain *sensory elements*, further modes of molecular motion, but also the *sensation* red; and yet the sensation red is also at the very same time in the "real" outer object. This doctrine is incoherent. Among other things there is a thimble-rigging with the words "sensory" and "sensation;" the former is the name of certain nervous elements, the latter is the name of the psychical accompaniment of activities of these nervous (physical) elements in our highest centres.

SECTION VI. *Subject Consciousness—The Introspection of Consciousness.*—It would be better to say Consciousness of Self, better still, Self-consciousness, and best of all, merely Self. The expression Consciousness *of* Self is, indeed, tautological. Moreover, I think it may be erroneously taken to countenance the pseudo-explanation that Consciousness of Self is consciousness of the organism.[1]

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[1] Psychical states are never states of the organism. No one ought, of course, to speak of sensations as being states of sensory elements, or as being ideas of these elements. But we must be equally careful in other directions. We ought not to use such expressions as "ideas of

This is an "explanation" fit to pair off with the "explanation" that object consciousness is a consciousness of "real" outer objects, of objects which are colored, hard, &c., in themselves, that is, independently of any percipient.

Further, it is doubtful whether Consciousness is a fit term to apply without qualification to Self, that is, to that which we have *called* Subject Consciousness. Subject consciousness is vastly different from *states of* Object consciousness, which we say "come out of" Subject consciousness. This is not denying that it is psychical; on the contrary, the affirmation is that it is psychical, or at any rate non-material. What is suggested is that Self is not describable psychically in the same way that Object consciousness is. Nevertheless, I shall continue to use the term Subject consciousness, because Self consciousness and Self are not used in medical writings, so far as I know.

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movements." When we are acting we have no more "ideas of" contractions of muscles, or of activities of motor nervous arrangements of any centres effecting these contractions than, when we are looking at a red object (having the colour red), we have ideas of any retinal elements or of nervous arrangements of any centres representing them. I do not know that any one does use the expression "ideas of movement" when anything is actually done; that expression is used when we think of doing something, or when we remember a movement done; it is then just as illegitimate. When I actually move my arm (say that it is what is popularly called a "voluntary movement") there is a process from highest motor centres, through lower centres, then by nerves to some muscles, which are discharged in a particular way. This is a purely physical process and we have no ideas of any part of it. No doubt there are activities of sensory elements from skin, joints and muscles, back, so to say, to highest sensory centres. But this also is a purely physical process and we have no ideas of any part of it. I would put it that we have a vivid psychical state *concomitant with* activities of the motory and sensory elements of the highest motory and sensory centres engaged in the double physical process described. When we think of the movement, or remember it (popularly "have an idea of it"), the physical process is limited to the highest centres; *the very same* nervous arrangements of these centres are engaged, but they are slightly engaged, and the psychical state concomitant with the slighter process is faint. We do not think of, or remember anything physical; there is the physical process again slightly and incompletely, and we have the concomitant psychical state faintly and vaguely. Psychical states correlative with activities of motor elements of the highest centres have no name, except in the case of words. Some years ago I suggested the term psychical-movement, but I soon abandoned it; for I felt convinced that the definition I forced on it—that it was to stand for a psychical state *attending* activities of motor nervous arrangements of the highest centres—would be ignored; thus it would foster the very confusion I wished to guard against.

What is called the Introspection of consciousness is of states of Object consciousness already "come out of" Subject consciousness. Subject consciousness, that which has these states (popularly "contemplates," "reflects on," "arranges," "attends to," &c.), is not to be known in any such way. To put the matter Hibernically; we only know, in the ordinary sense of the word know, Subject consciousness, on its ceasing to be (properly, so far as it ceases to be) Subject consciousness—on its becoming Object consciousness. Using the word "self" for once, we may say that what is commonly called consciousness (object consciousness), is "a revealing of self;" in perception an "element" of a state of object consciousness is forced out of Self by something, not us, of the nature of which we know nothing, acting upon us.

Subject consciousness is something deeper than knowledge; it is that by which knowledge is possible. Perhaps we may say that it is an awareness of our existence as individuals, as persons having the objective states making up for each, the (his) Universe; it *is* us in an emphatic sense. Subject consciousness is the comparatively unchanging, the most unchanging. It is thus a Constant to Object consciousness which is the continually changing. Most unchanging, that to which all more changing is relative, is the same as unchanging.

SECTION VII. *The Anatomical Substrata of Subject Consciousness.*—Although it was said (Section VI.) that Subject consciousness is not consciousness of the organism, it was not meant that it has no correlative physical basis. I prefer the expression anatomical substrata. I say *anatomical*, because I hold that all divisions of the highest centres ("organ of mind"), like all lower centres, represent parts of the body.(1) The highest centres represent *all* parts of the body in most complex, &c., combinations. What follows must be taken as speculative.

I submit that the units making up that division of the highest centres which I call the anatomical substrata of Subject consciousness represent (properly re-represent) all

(1) To give an account of the anatomy of any centre is to show what *parts of the body it represents*, and the ways in which it represents them. (Anatomy must be carefully distinguished from Morphology.) Physiology is concerned with the functioning of nervous arrangements of Centres. Psychology is concerned with psychical states *attending* the functioning of the highest centres.

parts of the body, mainly sensorily, *in relation to one another*. Each unit is the whole division in miniature, but each is, if the expression may pass, the whole of it in *different* miniature. Using old-fashioned language, these unifying or synthesising centres are a series of miniature highest centres, each of which is in some degree "potentially" the whole organism, each is it "potentially" in a different degree and order of representation of all parts.

The anatomical substrata of Subject consciousness are more perfectly organised than the anatomical substrata of Object consciousness. They are made up of nervous arrangements in comparatively fixed relation to one another, they are comparatively "ready made up," comparatively unmodifiable in new ways. It is submitted that the "layers" of this division of the highest centres are more organised, less modifiable, more automatic, more "ready made up," inheritedly more nearly perfect (or more easily and rapidly perfected after birth) *in the order from lowest to highest "layers"* (the lowest being, I mean, most organised, &c.). It is an arbitrary proceeding to consider the anatomical substrata of Subject consciousness apart from those of Object consciousness. I shall speak of the latter further on in this article.

SECTION VIII. *On "Sensations" and on Association of Ideas.*—We said (Section II.) that there are, strictly speaking, no such things as sensations. If the constitution of the anatomical substrata of Subject consciousness be that ascribed to them in the last section we see that there is not a correlative physical basis for a sensation.

I have long earnestly contended that there are no abrupt localisations of parts of the body in any nervous centres. When a man is pricked by a pin in the middle of his back, and he feels it, then, as "he" or "his back" plainly signifies there is a complete state of consciousness, one of Object consciousness "come out of" Subject consciousness. Physically, the nervous impulses starting from a point on the periphery pricked "travel" to units of the highest centres *universally* representing, and not to units representing one part of the back only. We have, speaking here of the outer surface of the body, several separate highly sensitive(1) surfaces (retina, &c.) and many less sensitive

(1) As we are here describing a physical process, "sensitive" is not the right word, as it implies feeling. Perhaps the proper expression

surfaces (as the skin of the back and limbs) little distinct from one another. But we have highest centres made up of *universally* representing units ; to these units impulses from any part of the surface must come if they are strong enough. What we *call* the sensation of a prick on the back is, artificially, that element of a state of object consciousness, now most *en evidence ;* correlatively those of the universally representing units of the highest centres, ultimately in activity, represent the part of the back pricked more than they do any other part of the body ; the representation of many other parts of the surface by these units will be almost a vanishing point. Speaking metaphorically an impulse from the part of the back pricked, travels by comparatively fixed lines to the highest centres, and " finds its own " there, the units representing it most. But it "finds its own" along with all the rest; for those units representing it most yet represent also all other parts of the body in some degree. In general the anatomical substrata of Subject consciousness are centres of Universal Co-ordination, or, as we said, they are Unifying or Synthesising centres.

Here is a fit place to note again that popular psychology recognises duality of consciousness (Section IV.). There are such expressions as that " the (1) mind associates, combines," &c., (2) these or those mental states. But once more there is wrong order. Physically, as we have suggested, nervous impulses pass from surface to centres, which being to a great extent " ready made up " in the way mentioned there *must* ensue universal as well as special states. More generally, and now speaking of the psychical, there is no autocratic mind sitting at the top to receive sensations as a sort of raw material, out of which to manufacture ideas, &c., and then to associate these ideas. I say this, for one reason, lest the term synthesising should, as co-ordinating often does, suggest the notion of some sort of an independent faculty (see Section XI). Answering to the constitution, mainly inherited, of the anatomical substrata of Subject Consciousness, ideas, &c., rise up combined, in association,

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where " highly sensitive " is used in the text is " a surface with numerous sensory elements of great instability " ; this expression involves nothing psychical. The term sensory is always used in this article for physical elements. *Concomitant with* activities of sensory elements of our highest centres (not *from* those activities) sensations (psychical states) arise.

&c.; and "coming out of" subject consciousness, they then constitute the Object consciousness of the moment.(1)

SECTION IX. *On Constants.*—In some later sections I shall deal with Constants (Forms of Thought) in detail. I speak of them at present merely in order to illustrate further what was said in Section VI.—that Subject consciousness is a Constant to Object consciousness—and to uphold the view I take of the kind of constitution of the anatomical substrata of Subject consciousness. I accept Herbert Spencer's doctrine of the inheritance of Organised experiences.(2) But if forms of thought are supernaturally given, it is reasonable to infer that their physical bases were given with them; as more generally, also on the hypothesis of supernatural derivation, brain was given with mind. As an evolutionist, I adopt Herbert Spencer's opinions on the origin of the physical bases of

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(1) This is not well expressed. I do not mean that there are fixed nervous arrangements answering to particular ideas, &c., in the anatomical substrata of Subject consciousness; there are only such nervous arrangements at the time when the ideas, &c., are actual. At other times the cells and fibres in constant activity keep up a state of general tension (nervous tonus); it is on the particular breaking of this strained equilibrium that nervous arrangements temporarily exist. There may be said to be latent or potential nervous arrangements; these are, however, not good expressions. There are, no doubt, in effect, degrees of fixity of nervous arrangements from those strongly organised, very automatic, and comparatively settled and unalterable, up to those now making ("nerve stuff" being for the first time traversed by nerve currents developed by the more and earlier organised nervous arrangements); those "now making" will be of course least organised, least automatic, and capable of most modification. The order from most strongly organised, &c., to least organised, &c., is the order from lowest towards highest layers of the highest centres. By the expression "in effect" I mean that some elements of centres will easily and inevitably fall into certain temporary groupings on particular excitations, and with difficulty into any others on any other excitations; whilst there are other elements of centres which can be forced by strong excitations, and with difficulty into quite new groupings. Many of the new—recently made—nervous arrangements will be evanescent; I mean that they will soon cease to be even the "potential" nervous arrangements I spoke of. I suppose that one of the "uses" of sleep is to sweep the higher layers of the highest centres clean of many such nervous arrangements.

(2) " . . If there exist certain external relations which are experienced by all organisms at all instants of their waking lives—relations which are absolutely constant, absolutely universal—there will be established answering internal relations that are absolutely constant, absolutely universal. Such relations we have in those of Space and Time."—Spencer, "Prin. Psych.," Vol. 1, p. 467.

the Constants—that they have been slowly evolved, organismally and racially; they are inherited imperfect and are rapidly perfected after birth. I submit that what is said may be a correct account of the physical bases of the Constants, even on the hypothesis that a man was created with them fully developed. Spencer must not be held answerable for my applications of his doctrines. The term Constant is one of my own devising as a synonym for Form of Thought. I shall only deal at present with the physical basis of the Time Constant, which is, I suppose, a certain kind of representation (Section XV.) of the cardiac systole in the highest cerebral centres ("organ of mind"). Before beginning this task I must try to clear the ground of some small difficulties.

SECTION X. *On Estimation of Time.*—It may be said that our "Idea of Time" is of external sequences, measured by certain well-known standards. These standards are, in civilised countries, some fractions of solar rhythms, symbolised on our clocks and watches. These standards are arbitrary.(1) They might be such vague ones as "as long as it takes the kettle to boil," or any other; such standards are inexact, but not more arbitrary than seconds, minutes, &c.

To say that we have notions of Time in having the objective states we call "external" sequences, estimated by objective standards, is to give but half the truth. But this truth, so to call it, without the other half is nothing at all. Nor does it avail to say that we have notions of Time from "internal" sequences, (of our ideas, &c.). For internal sequences, as we call them, are objective too, only differing from "external sequences" in degree of objectivisation; the "external sequences" are vivid, the "internal" faint, states of object consciousness. So that "internal" sequences, taken along with "external" sequences and the objective standards are nothing by themselves for our notion of Time. *There would be no objective sequences for us, subject, unless we ourselves were going on at some rate independently of, and, so to say, "out of," those objective sequences.* We have Subjective standards, or, as I call

(1) Evidently, taking a simpler case, a pound is only a mass equivalent to a certain lump of platinum kept at the Mint. We should smile if anyone were to say, "How was it ascertained that that lump did weigh a pound?" A despot might decree that his crown should be the standard of mass and weight in his dominions.

them, Constants as well as Objective standards. We inherit rhythms, the physical bases of the Constant Time (subject), and choose objective standards to measure "external sequences" by.

SECTION XI. *General Remarks on Parts of the Body, and on their Representation by Nervous Centres—Peripheral or Statical Co-ordination—Fixation of Limits; Things given by Inheritance to start with.*—I now return to the supposition (Section IX.) that the physical basis of the Time Constant is "a certain kind of representation of the cardiac systole in the highest cerebral centres." The heart, with all other parts of the body outside the central nervous system, makes up the Lowest Level of Evolution *of the whole organism.* The central nervous system (I speak only, however, for the present, of the Cerebral System) consists of three levels(1) lowest, middle and highest; these, respectively,[2] represent, re-represent and re-re-represent, all parts of the body. For emphasis, I repeat part of the last statement by saying that the highest level (series of highest centres or "organ of mind") re-re-represents all, literally *all*, parts of the body in most complex sensori-motor combinations.(3)

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(1) This triple division must be taken as hypothetical. I suppose no one denies that there are at least two levels, whether they speak of Evolution or not. Ferrier does not approve of my division of the anterior cerebral lobe into middle motor centres ("motor region") and highest motor centres (part of the brain in front of the "motor region").

(2) I have been told that the word "represent" is a bad one for the process spoken of in the text. It is not one of my own application to Evolution. It has only recently occurred to me as possible, that it may be taken to mean that parts of the body are represented, as a borough is in parliament, by delegation. This is what I do not mean. A higher centre *is* a lower, or many lower, "over again" in a more complex, &c., way; *is* the lower, "raised to a higher power."

(3) That the highest centres are sensori-motor, that they represent parts of the body, that they represent all parts of the body, and that each unit of them is universally representing, are things of vast importance in that aspect of the Anatomy and Physiology of the Nervous System which most evidently corresponds to Psychology. I have been long imbued with these notions; they are largely hypothetical, some altogether so; they are certainly not accepted even as hypotheses. I am not aware that any one but Ferrier agrees with me in thinking that the præfrontal lobes are motor; as already said, he thinks that my separation of them, as highest motor centres, from the "motor region" (middle motor centres) is not justified. I re-quote from the *Medical Press and Circular* (October 21st, 1874, p. 320) what I wrote, except for a few verbal changes, *Medical Mirror*, October, 1869. "We have now, then, to add to the constitution of the units of the cerebrum nerve

Hence it is not enough to say that, for every psychical state there is a correlative physical state of cells and fibres of the highest centres; that is only giving a morphologico-physiological account of the correlative physical process. We should say of cells and fibres of those centres making up *sensori-motor nervous arrangements*, that is, nervous arrangements representing (re-re-representing) impressions and movements of parts of the body; we thus give an anatomico-physiological (see footnote to Section VII.) account of the correlative physical process. In strictness (see Section VIII.) we should say that the physical state (correlative with any psychical state) is of nervous arrangements, or units (of the highest centres) which are universally representing; although those concerned during this or that psychical state represent this or that region of the body most especially.

It follows from the foregoing that, taking up Evolution after birth, we should begin with the Lowest Level of Evolution of the whole organism, with, that is, what we have called "parts of the body." We shall only make a few general remarks on this matter. We must premise that Representation and Co-ordination are the same thing; wherever impressions and movements are represented there they are co-ordinated. Higher, and so-called co-ordinating, centres, in contrast to lower, representing centres, are only centres, which (being evolved out of the lower) re-represent (represent indirectly) in more complex, &c., combinations the parts of the body which those lower represent

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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." . . . "When in the cerebrum [highest centres] we have arrived at an inter-relation so great that *each part* of that organ contains processes for movements of the *whole* of the body, we can, as aforesaid, understand that destruction of much of that organ (highest centres) may lead to no symptoms . . ." In the *Medical Press and Circular*, March 1st, 1876, "On the Scientific and Empirical Investigation of Epilepsies," I wrote " . . the implication is that in the slightest local impressions the whole organism becomes affected in the sense that the highest nervous arrangements *representing the organism as a whole* are disturbed." I should have said, of course, "local impressions strong enough to overcome the resistance of the lowest sensory centres," and thus that of the middle and highest. Since the article in the *Medical Mirror* was written, Gaskell has revolutionised our opinions on the sympathetic system.

(represent directly) in simpler, &c., combinations. Thus supposing that the current doctrine as to the anatomico-physiological service of the cerebellum is true—that it "co-ordinates impressions and movements of locomotion"—this means that the cerebellar centres *re-represent* parts of the body in the order, speaking roughly, back, legs and arms, in more complex, &c., combinations than they have been directly represented in by certain lowest motor centres. Hence negative lesions of the cerebellum do not produce "disorder of locomotion": they produce paralysis, in the sense of loss of some movements of the parts of the body mentioned, and nothing whatever else. The erratic movements in the reel are "forced movements," and are owing to over-activity of nervous arrangements which are perfectly healthy. (Probably the cerebrum is trying to do the work of the cerebellum.)

Co-ordination begins on the peripheral side of the lowest centres, that is, in parts of the body, that is, in the Lowest Level of Evolution of the whole organism. There is what we may arbitrarily distinguish as Statical Co-ordination; the sizes and shapes of the bones, the sizes and dispositions of the muscles, &c. The centres can only represent parts of the body as they are; a hinge-joint and the muscles moving it can only be represented in one way, however high the evolution of centres representing them may be. Evolution implies *limits* to start with. Another aspect of this is that individual evolution starts with "things *given*" by inheritance, some of which are mechanically fixed. In what have been called the "imperfections of our eyes" there are, I suppose, these limits which are also "things given by inheritance to start with." Were not the vertical and horizontal curves of the corneæ slightly different,[1] it is hard to see how we could begin to learn such minute—or, as we may say, "insect"—differences of distance, as roughness of an object, say sand-paper. Again, were not the eyes at a fixed distance apart, or, if there be but one eye, an eye movable *in a certain limited range only*, it is hard to see how a man could begin to learn larger differences of distance. A "base line is given to start with." Roughly speaking, and using old-fashioned language, we may say that on account of the statical co-ordinations of the corneæ, vertical lines *are*

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[1] I am speaking of what is called normal astigmatism, not of high degrees of astigmatism, nor of irregular astigmatism. So to say, some parallax is "given to start with."

in Nature further from us, and that horizontal lines *are* nearer to us. Speaking correctly, certain parts of our periphery are at birth in statical correspondence with our environment. We only know light by contrast with darkness, and only know darkness in contrast to light. (The congenitally blind have no notion of either.) We have the basis of this contrast fixed, so to speak, in the periphery, which light affects; there is a "blind spot" in an area of visual acuteness, which acuteness diminishes from the yellow spot to the retinal periphery. Similarly, for the spherical and the chromatic aberration of the eyes. Red is "in Nature" nearer to us than blue—or speaking correctly, what the physicist calls red rays provoke a stronger accommodation.(1)

Speaking most generally, we may say that every part of the body has its "peculiarity;" each is more or less a fixation of a limit, and yet is at the same time something given at birth to start with. These peculiarities must be respected however high evolution of nervous centres is carried. Here is stated one important thing connected with the doctrine of Localization I hold. I have already (Section VIII.) said that units of the highest centres are at once universally (factor Integration), and specially representing; that every unit represents all parts of the body, and yet that each represents some one part of it first and most. This is repeating that the peculiarity of every part of the body is respected, however high evolution is carried. The fact that a man can shrug his shoulder of necessity implies that the movements effecting this operation have, in some part of the highest centres, a more special representation than all other movements have in that part. In so far as any part of the body (lowest level of Evolution of the whole organism) has a degree of independence of the rest, in so far it has a corresponding degree of speciality of representation in the highest centres. I hope these remarks will be borne in mind by those who object to the use of the term "centre"; they will see that I do not use it rigidly. Thus the "arm centre" in the Rolandic region (middle

(1) Professor S. P. Thompson writes ("Proc. Phys. Soc. of London," vol. ii. p. 170), I quote at second-hand from "Science for All": "Reflecting how useful is the purpose subserved thus by the non-achromatism of the eye, I consider it probable that, if the eye were so constructed as to be originally achromatic, having usually blue distances and red-brown foregrounds to look at, it would, by an inevitable process of natural selection, develop into a non-achromatic instrument."

motor centres) is for me a centre representing movements of all parts of the body, but yet movements of the arm very much more than any other movements.

We now cease to speak generally of parts of the body, and take up for consideration that particular part of it, the heart, a certain re-re-representation of which in the highest centres is supposed to be the physical basis of the Time Constant. If what was said generally on "statical co-ordination" of parts of the body (of "fixation of limits" or "things given by inheritance" to start with) be valid, it is most methodical to begin further exposition by (1) detailing certain "peculiarities" of the heart. For we have just said in effect, that even the highest centres can only be all parts of the body "over again," in most complex, &c., combinations. Although Mind is not "got out of" the body, its physical basis is. The heart, like all other parts, will have its "peculiarities" respected however high evolution is carried.

It may be well here to point out further steps by which our main subject will be approached. We shall speak of (2) Representation of the heart in centres of the three different grades or levels of Evolution, (3) of several *kinds* of representation of it in the highest centres, taking, however, in a separate Section (4) the one particular kind of representation of the systole of the heart in those centres, which is supposed to be the physical basis of the Constant Time. I beg the reader never to forget that, reiterating, it is not the heart, but (*a*) a certain kind of representation of (*b*) its systole in the (*c*) highest centres, which is supposed to be the physical basis of that Constant.[1]

SECTION XII. *Peculiarities of the Heart.* The heart is the most autonomous of all organs. A frog's heart, cut out of its body, beats for two and a half days, but this is at the longest; an excised dog's heart beats ninety-six hours.[2] [3]

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[1] I say this partly because I have formerly written as follows "Hospital Reports" (*Medical Times and Gazette*, August 7th, 1875): "Dr. Hughlings Jackson believes that intervals are learned by movements of the heart; that our ideas of time have final, although unconscious, reference to the rhythm of the heart, as our ideas of space have to movements of our locomotor organs."

[2] See Landois' and Stirling's "Physiology," 2nd ed., vol. i., p. 106.

[3] "The muscle of the heart remains longer irritable than any other muscular structure," McKendrick "Text Book of Physiology," vol. i., p. 405.

The heart "holds out" longest in general injurious influences, as for example in the coma of acute alcoholism.(1)

The heart is always working, day and night, all our lives. It is always working in the same way and very much at the same rate; physiologists set down what is the average rate for this or that period of a man's life; it is about 72 at adolescence.

The heart is the most nearly perfectly rhythmical organ; having in normal states nearly a succession of similar movements at equal intervals.

The heart has the striking peculiarity that its muscle acts differently from ordinary skeletal muscle to certain stimuli, and in a way which shows plainly the great autonomy of the organ. Lauder Brunton writes, speaking of the application of a single induction shock to the apex (lower two-thirds of the ventricle) of the frog's heart, that "it answers by a single contraction, just like any other muscular fibre" ("Pharmacology:" 2nd Ed. p. 304). But then he says too, still speaking of the application of a single induction shock, "The difference between the reaction of an ordinary striated muscle and of the apex to such a shock is, that the heart, instead of responding by a strong or weak contraction to a strong or weak stimulus, either does not contract at all, or contracts with as much force as it can exert. The weakest stimulus which will act at all, and the strongest have thus exactly the same action, or in other words, a minimum is also a maximum stimulus." (Op. Cit. p. 304.) Foster ("Physiology," 4th ed., p. 180) says: "One great feature of the cardiac beat produced by artificial stimulation is the absence of that relationship between the strength of the stimulus employed and the amount of contraction evoked which is so striking in a skeletal muscle. The beat with which a heart responds to a stimulus, *e.g.*, a single induction shock, is, if there be any response at all, equally large when a feeble, as when a large stimulus is used, though the strength of the beat evoked either by a strong or a weak stimulus may vary considerably within even a very short period of time." Landois and Stirling in

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(1) Mercier writes, *Brain*, January, 1887, p. 472, "To sum up the bodily condition of the comatose patient; there is paralysis, more or less complete, of all the voluntary muscular system; there is incomplete paralysis of the muscular system of the skin, of the arteries, of the bladder, of the pupil; there is incomplete paralysis of the respiratory system; *and the muscles of the heart appear to be the only ones that are not weakened in some degree.*" (No italics in original.)

their "Physiology," 2nd ed., vol. i., p. 120, write: "It is quite clear . . . . that the relation of the strength of the stimulus, to the extent of the contraction of the cardiac muscle, is quite different from what occurs in a muscle of the skeleton, where, within certain limits, the amplitude of the contraction bears a relation to the stimulus, while in the heart the contraction is always *maximal*."

Dr. J. A. McWilliam writes (*Journal of Physiology*, vol. ix., Nos. 2 and 3, p. 168, August, 1888), "A conspicuous feature in the behaviour of the cardiac muscle of cold-blooded animals under the influence of single stimuli is the fact that minimal stimulation is at the same time maximal. The contraction excited by a strong induction shock is no larger than one excited by a weak induction shock of strength just sufficient to act as a stimulus; whatever be the strength of the excitation applied, provided it is strong enough to cause contraction at all, the response is always maximal (Bowditch, Von Basch, Kronecker and Stirling). This law seems also to hold in the case of single stimuli, other than electrical (*e.g.*, mechanical or thermal stimuli); it constitutes a fundamental point of difference between the behaviour of the cardiac muscle and that of voluntary muscle.

"As the result of a large number of experiments on the mammalian heart, I find that the same law holds good."

There is another peculiarity a consideration of which will bring us back to the peculiarity previously mentioned, being bound up with it. "The systolic contraction is of very much longer duration (8 to 10 times) than the contraction of a skeletal muscle produced by stimulation of its motor nerve." (Landois' and Stirling's "Physiology," 2nd ed., vol. i., p. 122.) Foster writes . . . "the evidence, although perhaps not conclusive, goes to show that the beat of the heart is a slow long-continued single spasm, intermediate between the contraction of an ordinary striated and that of an unstriated muscle, and not a tetanic contraction." ("Phys.," 4th ed., p. 145.) Foster, however, does not conclude that "the heart knows no tetanus" as some physiologists have done, but yet gives some facts which, he says, "renders it difficult to suppose that the beat is really a tetanus."

The following is from Dr. McWilliam's paper, p. 179:—"It appears that the cardiac muscle throughout the whole vertebrate series is possessed of certain strongly marked and peculiar characters. Its molecular arrangements are

such that any discharge of energy is necessarily a full and maximal discharge; there is no partial or graduated discharge possible at any moment, apart from the influences of nerve control, distension of the cavities, temperature, &c. A discharge of energy induces a period of exhaustion which renders a second discharge impossible until a certain degree of reparation has been attained; in this way the occurrence of a steady and prolonged discharge—like that of a complete tetanus in a skeletal muscle—is prevented; hence continued stimulation (*e.g.*, with galvanic currents or weak faradic currents) leads to a series of contractions, and not to a steady tetanus."

So much for "peculiarities" of the heart. In the next Section I shall speak of some peculiarities, or rather, significant associations, of its first representation in the central nervous system.

SECTION XIII. *Representation; Re-representation and Re-re-representation of the Heart, in Lowest, Middle, and Highest Centres Respectively; otherwise, First, Second, and Third Representation.*—That the heart is represented in the Lowest Level of Central Evolution is accepted doctrine. There are a cardio-inhibitory and an accelerating centre in the medulla oblongata. This is Representation (first representation). There are some facts significant to my main topic to be stated here.

The vagus is a sensory nerve, obtaining its inhibitory and motor endowment from the bulbar part of the spinal accessory; the vagus, sensorily, is, among other things, afferent to the cardio-inhibitory centre. It is significant that the vagus nucleus has close relations to the nucleus of the sensory nerve, called auditory (inner auditory nucleus). I say *called* auditory. One division of the nerve is from the cochlea, for reception of aerial vibrations; the other division is from the semicircular canals (for reception of coarse vibrations during movements of the body) (?) and serves in regulating locomotor movements in relation to one another. It is significant that the nucleus of the vagus (since this nerve, sensory, is, among other things, reflexly, one regulator of the most rhythmical organ, the heart) has close relations to the inner auditory nucleus. The auditory is the sense preeminently appreciative of(1) times—intervals between certain

(1) I do not mean by itself any more than I suppose that impressions on the retina by themselves form, or form part of, the physical basis of extension.

successions, those of sounds. Both divisions of the so-called auditory nerve and related central nervous arrangements, are engaged rhythmically in dancing to music.

Consequent on consideration of the "vital" and "locomotor" symptoms of cases of Aural Vertigo from disturbance starting in both (labyrinthine,) divisions of the so-called auditory nerve I would suggest (See *Medical Times and Gazette*, Aug. 7th, 1876) that the true auditory (cochlear) division is one of the nerves afferent in a particular way, round by the cardio-inhibitory centre, to the heart. Music, if this be so, among other things, "plays on the heart." Gaskell tells us that inhibitory fibres are anabolic, that their action improves nutrition; thus, in the relation mentioned, we find part of the explanation of the cheering effects of music that is in its heightening vitality, and also an explanation of the disagreeable effects which sudden harsh noises produce. The other, the semi-circular canal division, is, I suggest, afferent to the cerebellum, and very likely also, to certain motor centres in the medulla oblongata and pons which serve in co-ordinating large (gross) movements of all parts of the body in simplest relations to one another.[1] In the article[2] already referred to (see

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[1] I hope in another article to be able to shew that the Lowest Level of central Evolution is so far complete in itself as to form an anatomico-physological unity. I do not mean only that it is complete in itself because it represents all parts of the body, as it evidently does, since to and from it nerves supplying all parts of the body come and go. I submit that in the higher (anterior) divisions of the vertebrate's Lowest Level are rudimentary highest centres representing, that is, co-ordinating, *all* parts of the level in simple ways. These rudimentary highest centres are what, in the text, I have spoken of as "certain motor centres in the medulla oblongata and pons"; they are supposed to re-represent, in somewhat more complex combinations, what *all* the lowest centres of the lowest level have represented in simple ways. Whatever any one may think of Northnagel's term "convulsion centre," his discovery of a part in the higher divisions of what I call the Lowest Level, excitations of which part produces universal spasm, is one of great value. This so-called "convulsion centre" I suppose enters into the centre I have suggested as being the rudimentary highest centre of the lowest level. *Using the term epilepsy generically* there are, I submit, three classes of epilepsy. Since, however, in spite of the qualifying words in italics, the term epilepsy will carry with it its customary connotations, I will substitute the term "fit." There are, I think, (1) "Lowest Level fits" (laryngismus stridulus, &c.); (2) Middle Level fits (epileptiform, &c., seizures); and (3) Highest Level fits (epilepsy proper).

[2] For a criticism of that article see Gurney's "Power of Sound," Appendix B., p. 547.

Section XI., footnote) I supposed that the relation spoken of was the physical basis of "our ideas of time." I now only give the facts stated in this and the preceding paragraph as, like those of the "peculiarities" of the heart (Section XII.), being significant in regard to (as foreshadowing, so to speak) the kind of re-re-representation of the heart in the highest centres, which is supposed to be the physical basis of the Constant Time.

We now come to consider the second representation of the heart, its re-representation, in the Middle Level of Evolution, the so-called "motor region." At first I speak generally of the circulatory apparatus; the arterial system as well as the heart is re-represented in the Middle Level. From observations on cases of disease of the brain, and from consideration of bodily effects during emotions, I long ago arrived at the conclusion (see footnote [3], Section XI.) that the circulatory organs and all other parts of the body are represented in units of the cerebrum "in the region of the corpus striatum at least"—a vague description of the motor region.([1]) As will be seen I now think that all parts of the body are not only re-represented in the "motor region," but also again in (re-re-represented in) the highest centres. The circulatory apparatus which enters with other parts into the physical bases of emotions, is represented in the highest centres. Keeping, however, to the "motor region" (middle motor centres) for the present, I remark that experiments on some lower animals supply the most definite evidence of representation of the circulatory apparatus in those centres.

François-Franck in his most valuable work "Leçons sur les Fonctions Motrices du Cerveau (Réactions volontaires et organiques) et sur l'Epilepsie Cérèbrale" gives an account (among many other important and brilliant researches by himself and Pitres) of circulatory effects produced by excitation of the "motor region" of the cortex. He refers to the previous researches of Schiff, Vulpian, Bochfontaine, Lépine and many others. The effects produced on the organic parts in curarised animals are, he gives good reason for believing, nearly always of an epileptic nature. But this matters little for my immediate

([1]) In those days, it must be remembered, the assertion that convolutions represent movements of any kind, even of the limbs, received no attention. Hence the indefinite statement "in the region of," &c., was then excusable.

purpose, which is only to show that the heart as well as other parts of the circulatory apparatus is represented in some way in the "motor region." An epileptiform fit, even experimentally produced, is only a brutal development of normal function; even in its excess the order of representation of parts of the body in the centres suddenly, &c., discharged must be respected.

I must say here, however, that Franck remarks "Nous considérons au point de vue spécial des réactions cardiaques, comme au point de vue des autres réactions organiques, la surface excitable du cerveau *comme comparable à une surface sensible*, et nous ne voyons aucune raison pour admettre des centres cardiaques, soit modérateurs, soit accélérateurs, en un point quelconque de l' Ecorce cérébrale : il y a là des points de départ de réactions et non de véritables centres" pp. 205-6 (no italics in original).

Franck comes to the conclusion that "*le ralentissement du cœur est lié à la periode tonique, l' acceleration à la periode clonique des grandes acces.*"

Franck, p. 205, does not find that excitation of any one part of the "motor region" is more efficacious than that of any other in producing slowing or acceleration of the heart. As I have suggested, speaking of the highest centres (*Medical Press and Circular*, March 1st, 1876, p. 176): "One would not expect the systemic movements to be so specially represented as the higher [animal] movements, [for example] those of the eyes and hands."

We now consider the third Representation of the heart, its re-re-representation in the highest centres. I submit that it is certain that it is represented in those centres. The facts of emotional manifestations (physical effects *during* emotions) seem to me to demonstrate it. It is necessary here to speak very generally of emotions and of emotional manifestations (bodily effects *during* emotions) in order to show that the organic parts, the heart among them, are, with animal parts, represented in the highest centres. We must carefully distinguish between the psychical and the physical. An emotion is an element in a state of (object) consciousness (Section II.), and of necessity the highest centres are concerned during it. It may be said that an emotion causes the heart to beat at an abnormal rate. This hypothesis, that a psychical state produces a physical effect, is untenable. It is not even a good materialistic view of the matter. The thorough-going

materialistic statement would be that a process which at once is both nervous and psychical produces the manifestations mentioned. Rejecting the hypothesis of crude materialism I submit that the *physical basis* of what is the psychical state an emotion is of nervous arrangements of the highest centres especially *representing those parts of the body concerned in, and as they are concerned in, the manifestations of that emotion.*[1] For example, the physical basis of anger (the emotion of combat) is of nervous arrangements representing the circulatory, respiratory and digestive systems, sphincters and other, no doubt all other, parts, animal and organic. This representation is of parts of the body in a particular combination, that of a hostile attitude, a readiness for attack. Whilst a man is slightly angry, without, if that be possible, any manifestations, there is, correlatively, a discharge of the nervous arrangements representing parts of his body in the combination mentioned, but not a discharge strong enough to produce peripheral effects. During greater anger the *same* series of nervous arrangements are discharged, but more strongly discharged so that peripheral effects are produced; there are then the manifestations, frowning, set teeth, firm closure of the sphincters, erect attitude, &c. Slight anger is a faint, great anger, a vivid element of a state of object-consciousness—(differences of degree of objectivisation of emotions are indefinite). Correlatively there are slight and strong discharges of nervous arrangements of the highest centres representing parts of the body as they are engaged in

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[1] In the Croonian Lectures, *British Medical Journal*, April 12th, 1884, I spoke of volitional, emotional, &c, centres (but only for convenience, afterwards repudiating those terms and their popular implications). I then wrote :—"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 the 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 sub-agency of the middle and lowest centres, produce the manifestations."

I earnestly beg the reader to observe that nothing in this quotation or in the text implies that activity of any nervous elements of the highest centres representing any parts of the body as they are concerned in manifestations of anger, fear, &c., *is* an emotion; the emotion is merely *concomitant* with that activity, or, equivalently, *arises during* that activity.

combat, but as we said, in the former case not reaching, in the latter reaching these parts of the body.(1)

Perhaps it may seem that fear would be a simpler case for illustration so far as representation of the heart in the highest centres is concerned. It is, however, a legitimate assumption that the heart is reined in during anger(2) by inhibitory nervous influence. That the heart is greatly affected during fear is certain. I submit that fear is anger "broken down" prematurely, that the physical condition for it is especially an exhaustion of inhibitory and other leucenteric(3) fibres consequent on discharge beginning in the highest centres in the preceding stage of anger. Or it is what would, in a strong man, be anger, physically readiness for attack. I mean, to give but a fragmentary illustration, that during the anger of a strong man currents coming down from his highest centres would beneficially curb the heart by intermediation of inhibitory fibres in the vagus, but that in the weak man they would, the suggestion is, very soon exhaust those fibres; the heart would then be "let go." Of course some degree of exhaustion, not necessarily utter exhaustion, is meant. There would then be the physical condition for fear.(4)

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(1) For an account of the physical manifestations during fear and anger, and for an explanation of them, see Spencer ("Prin. Psych.," vol. i., p. 472, and seq., and vol. ii., p. 539, and seq.).

(2) Anger is not the right word in this connexion. I suppose that "sense of power" would be a more fit one. Anger with calling out of reserves of power, and fear with diminution of power, are departures from the general state of equilibrium—departures by degrees of plus and minus respectively. The two emotions are often mixed, possibly always. I hope, further on, to consider the emotions on a more fundamental basis. What is said in the text will serve for illustration.

(3) In the text Gaskell's terms leucenteric and polio-enteric are used. I take this opportunity of acknowledging my very great indebtedness to him for the help his most valuable researches and important generalisations have given me in the analysis of epileptic fits, and in many other ways. (See his paper "On the Structure, Distribution, and Function of the Nerves which Innervate the Visceral and Vascular Systems," *Journal of Physiology*, vol. vi., No. 1, January, 1886.)

(4) Let me compare and contrast some of the manifestations of anger with some of those of fear, in order to show that the latter are after-effects of the discharges in the former, that they are exhaustions, that they are essentially paralytic effects. In anger there would seem to be increase of saliva ("foaming with rage"); in fear there is dry mouth (the saliva previously over-secreted being swallowed?) In anger it is supposed that the heart is reined in by intermediation of fibres in the vagus; its going too fast in fear is explicable on the hypothesis

At any rate the evidence of emotional manifestations shows that the heart, among other parts, is *somehow* represented in the highest centres, and that suffices for the present stage of my argument.

There is, as yet, no experimental evidence commonly so called, to show that the heart is represented in the highest centres. The experiments of Franck, Pitres and others show that it is represented in the "Motor region." But to me this region is the Middle Level of Motor Evolution; the præfrontal lobes being the Highest Motor Level, highest motor centres. It is to discharge beginning in parts of the highest motor centres—and I suppose, in some cases, in the highest sensory centres—that fits of epilepsy proper are owing. These fits are "experiments made by disease," and show, although in a very rough way, that the organic parts, the heart among them, are represented in the highest centres. The heart is slowed in some slight seizures of *le petit mal.*

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of subsequent exhaustion of those fibres. In anger the sphincters will be tightly closed; in fear there are alvine evacuations; this however is partly, I suppose, owing to exhaustion of the leucenteric fibres of the splanchnics. The over-secreted sweat lies on the skin in fear, but I submit that the sweat is produced by discharge during the previous stage of anger; it cannot be got rid of as the saliva can. The further supposition is that the polio-enteric fibres are not exhausted, or are less exhausted than the leucenteric fibres in fear, which is, according to the hypothesis stated, an after stage of anger. The centres for the accelerator nerves (increased rate of cardiac action) for the polio-enteric fibres of the vagus (alvine evacuations) and, I suppose, for the vaso-motor fibres, will be in unantagonised activity when those for the corresponding leucenteric fibres are exhausted. The pupils are said to be dilated in fear. I confess that at present I am unable to explain this on the hypothesis stated regarding other parts. The innervation of the pupil is a very complicated case.—See Gaskell, *Op. cit.*, p. 38.

I would here remark that atropine seems to me to have a preference (to speak figuratively) for those parts of the organic system affected during fear; still speaking figuratively, it seems to me to imitate the condition during fear. I mean on the hypothesis that fear is an after-effect of anger, or is anger prematurely broken down. The mouth is dry in fear, atropine checks salivary secretion. The skin is not dry in fear; atropine dries the skin; there is, however, "cold sweat" in fear, and the hypothesis is that the sweat was produced during the prior stage of anger, and left there. In fear, the hypothesis is that the leucenteric fibres of the splanchnics are exhausted, and no doubt the help of belladonna, when added to an aperient, is by paralysing these fibres. Atropine stimulates the respiratory and vaso-motor centres, and possibly all centres as they empower organic parts by polio-enteric fibres (rapid respiration, pale skin in fear). In the same way, muscarin, the so-called antagonist of atropine, "imitates" the effect of anger.

The representation of the heart in the highest centres is supposed to be a very even one, that is, *a very equal one in every unit of those centres*. I have long held the opinion that the heart is thus universally represented in the highest centres. I give the following quotation from an article "On Epilepsies and on the After-effects of Epileptic Discharges" ("West Riding Asylum Reports," vol. vi. p. 270-1, 1876). It can be read with the quotations from other articles given in Section XI. "It would be a very remarkable thing if the organic functions *were not* represented in the cortex cerebri. It would be very remarkable if the highest centres, the substrata of consciousness, did not represent the whole organism, the tissues, viscera, arterial system, and muscles. The physical phenomena occurring with loss of consciousness, in cases of *le petit mal*, would be unintelligible if the 'organic functions' were not represented in the very highest centres. *It would be most remarkable if the heart were not represented in every unit of the very highest centres*" (no italics in original). I was not at that time thinking of the Constant Time. I give a further quotation from that article, p. 271, on the representation of organic parts in the highest centres, partly in order to reproduce some important remarks by Bain contained in it. "Equally unintelligible would be the occurrence of the bodily manifestations observed in normal emotion, or in the abnormal emotion of hysteria. These manifestations are exhibited in 'all parts of the moving system, voluntary and involuntary; while an important series of effects are produced on the glands and viscera, the stomach, lungs, heart, kidneys, skin, together with the sexual and mammary organs.'" (Bain, *The Emotions and Will*, p. 4.)

So far we have spoken of representation of the heart in the three Levels of Evolution, regardless of *kind* of representation. In the next Section we shall speak of three different kinds of representation (re-re-representations) of it in the highest centres. In a later section we shall speak of a fourth kind of representation of it in the highest centres, that which is supposed to be the physical basis of the Time Constant.

SECTION XIV. *On Three Different Kinds of Representation of the Heart in the Highest Centres.*—(1) First Kind of Representation. There can be, I submit, no doubt but that all parts of the body are represented in nervous centres—represented in their most general character as

tissues—according to their state of nutrition. This representation of them in the highest centres (a sort of "universal suffrage") is most especially the physical basis of that, as it varies according to degree of nutrition and innutrition, to which we give the different names, *bien etre* or satisfaction or hunger. Muscle, because there is most of it, will be, in this way, what is most represented in that physical basis, the heart among other muscles, as so much muscular tissue.

(2) Second Kind of Representation. We must here go back a moment to remark once more on representation of the heart in the lowest level; its first representation. It is represented on that level as an organ doing menial work, along with other organs, respiratory, digestive, &c., which also do menial work. The heart is represented on this level as a pump, as a machine for circulating the blood. It is one of the Industrial Organs of Spencer, being one of the analogues of the Industrial parts of the Social Organism. In this character the action of the heart is made to vary according to varying needs of the system. But here we cannot limit attention to the heart; we must take into account the whole circulatory apparatus. If arterial tension be great the heart is slowed by efferent impulses descending the vagi; or if the heart beats too strongly afferent impulses passing up by the depressor nerve to the vaso-motor centre diminish peripheral resistance in the splanchnic area. In this way, as represented on the lowest level, that is as an organ doing menial work, the autonomy of the heart is within limits; it is, to a certain extent, an organ made to vary in rate.

I went back to representation of the heart in the lowest level because I wish to urge that the heart *as an organ doing menial work* is probably almost completely represented on that level, and that its representation in the highest centres in its "corporate capacity" in that way is almost a "vanishing point." The alterations in its rate, as an organ doing menial work, are effects produced by agencies on the lowest level and periphery, and very little, if at all, by impulses from the highest centres. To speak popularly, volition, or to speak correctly, the highest centres, have probably no directive or controlling power over it *in the way of making it work differently in its menial duty as a machine for circulating the blood.*

(3) Third Kind of Representation. In Section XIII.

we spoke of representation of the heart in the physical bases of emotions, that is, in the highest centres, simply to show that it *was* represented in those centres. We now speak of it again as one *kind* of Representation. The highest centres during emotional states have an effect on the heart, sometimes an enormous effect. The kind of representation of the heart in the physical bases of emotions (highest centres) is obviously vastly different from the second kind of representation of it (if there be any) in those centres as an organ doing menial work. For in so far as the heart is engaged during emotions, in so far does it for the time being cease to be of service as an industrial organ, that is, as an organ for doing menial work.

I have suggested that during the emotion of anger of a strong man, ready to attack, or in the attitude of attack, the heart is acted on by the highest centres and is restrained within bounds (Section XIII.). If fear be anger "broken down" the supposition is that the inhibitory fibres put in too strong action and in action too suddenly in the prior stage of anger, are exhausted, and exhausted before (Section XIII.) the less easily exhausted accelerating motor fibres are.(1)

During emotions, to speak figuratively, the highest centres care nothing about the heart's duty as a menial or industrial organ, but put in activity, during anger, its inhibitory fibres and also its accelerator fibres, as well as the vaso-motor fibres (the inhibitory being sooner exhausted), caring nothing for the body's need, that the rate of the heart and the height of arterial tension should vary inversely. Apart from particulars it is evident that during severe emotion, menial work is, so far as the emotion goes, interfered with. Manifestly the heart then serves badly as a pump.

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(1) The supposition is that inhibitory, I suppose I may say all leucenteric fibres, are sooner exhausted than motor, polio-enteric, fibres. "The inhibitory fibres of the vagus lose their excitability more readily than the accelerating fibres, but the vagus fibres are more excitable than those of the accelerans." (Landois and Stirling's "Physiology," vol. ii., p. 149.) I have submitted the hypothesis that leucenteric nerves are first involved in the epileptic discharge, and are sooner exhausted by that discharge. This is very important with regard to the methodical analysis of the epileptic paroxysms and post-epileptic states. According to Soltmann, inhibitory nervous arrangements are later developed (evolved) than the motor; if so we should expect them to suffer first and most in disease (Dissolution). Their late evolution explains how it is that children tolerate very large doses of belladonna.

The first kind of representation of the heart in the highest centres does not particularly concern us. The representation of all tissues, in the manner spoken of, is, however, of vast importance for things to be dealt with in other parts of this article. For the psychical side of it is, I submit, the point of departure by *minus* or *plus* of all emotional states. If this be so the representation of the heart, as part of the muscular and other tissues of the body is somewhat arbitrarily, although conveniently, separated from the third kind of representation of the heart.

I earnestly beg the reader to distinguish between the second and third kinds of representation, if there be any of the second kind, of the heart in the highest centres.(1) He is asked to take note also that not one of the three kinds of representation of the heart in the highest centres is supposed to be the kind of representation of it in the physical basis of the Time Constant. I put that, the fourth kind of representation of the heart, its systole, in a separate Section. It was necessary to write the present Section in order, besides other reasons, to effectually exclude from consideration the three other kinds of representation.

SECTION XV. *The Fourth Kind of Representation of the Heart in the Highest Centres. Representation of the Cardiac Systole in the Physical Basis of the Time Constant.*—I have spoken in Section XII. of "peculiarities" of the heart, and in Section XIII. of certain associations of its first Representation, that in the Lowest Level of Evolution. It was suggested that these peculiarities and associations have some significance in, so to speak, foreshadowing the *kind* of representation of the organ in the highest centres as the physical basis of the Constant Time. I say *foreshadowing*, because an old hypothesis that the heart itself was, or that the lowest cardiac centres, or both together, were the physical basis of our "idea of Time" was abandoned. For it was pointed out (Section XIV., 2) that the heart, as an organ doing menial work, varies in rate according to the needs of the system; the lowest (cardiac and arterial) centres are acted on and react so as to adjust the circulation in

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(1) Very likely the organic parts *as they serve during emotions* are more immediately connected with the highest centres—that is, that fibres for them pass through the middle centres without joining the cells of those centres—than the animal parts as serving "during volition" are.

varying bodily conditions. An organ, or centres for it, made thus to vary by agencies external to it, could not be a Standard for what we call "external" or "internal" sequences which vary according to very different conditions. Again, any nervous arrangements (Section XIV., 2) of the Highest Level (highest centres) which can make the heart alter in rate as an organ doing menial work, could be no Standard. It was, however, suggested that representation of the heart in that way in the highest centres is almost a "vanishing point," if indeed there be in them any such representation. That those nervous arrangements of the highest centres which form the anatomical substrata of emotions (Section XIV., 3), representing the heart among other parts, could be the physical basis of the Constant Time, is evidently an untenable hypothesis.

Nervous elements which are independent, and which do not vary, and cannot be made to vary in their rate of activity, can alone be a Standard to all else which is varying, can alone be the physical basis of the Time Constant.

I remark, once for all, that what has been and will be said on the kind of Representation of the heart as the physical basis of the Time Constant is purely hypothetical. But I submit that Forms of Thought, even if supernaturally given, must have *some* physical basis. That basis cannot be made up of anything else than *some* nervous elements representing *some* part or parts of the body in *some* way. Most generally the "organ of mind" is nothing whatever else than the highest level of Evolution, an "organ" representing all parts of the body. It is an irresistible inference that the physical basis of the Time Constant is of nervous elements representing (re-re-representing) *some* rhythmically acting organ, and presumably the heart, the most rhythmically acting. Once more suggesting that the representation in the physical basis of the Time Constant is of the heart's systole, I repeat that however high the Evolution of (representation of) this organ can be carried its "peculiarities" must be respected. To speak figuratively, Evolution cannot get out of the body more than there is in it (Section XI.); it can only make increasingly complex, &c., combinations by representation of the heart with representations of other parts of the body. The heart, a sphincter-like organ (a mere pump), can have a very wide representation, but can itself scarcely have much differentiation of repre-

sentation. A pure sphincter, *e.g.*, the pupil (iris),[1] can scarcely have any differentiation of representation; and the more sphincter-like a part is the less is differentiation in its representation possible, although no doubt in the highest centres, the wider is its representation. One would infer that the pupil (iris) will be represented in the physical basis of every visual image, in the physical bases of all Emotions, and in every nervous arrangement representing those ocular movements which symbolise locomotor movements of parts[2] of the body, and of the whole of it.

The first suggestion is that the kind of representation of the heart, its systole, as the physical basis of the Time Constant, is a very simple one. The next suggestion is that the nervous elements of the physical basis of that Constant are the most strongly organised of all nervous elements except those of the other Constants. The latter statement may seem to be contrary to the doctrine of Evolution. Let us consider it.

Evolution generally is a passage from the most[3] towards

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(1) Since this part was first published I have had misgivings as to the correctness of the inference that sphincters "can scarcely have any differentiation of representation," consequent on reading Jessop's very able paper on the Pupil and Accommodation (*Ophthalmic Review*, August, 1888.) Stimulation of one short ciliary nerve causes *partial* contraction of the ciliary muscle. As, however, centres are not concerned in this experiment, the fact may not be to the point. But under the subheading *Spasm of Accommodation*, Jessop writes, "In rarer cases there is partial spasm of the ciliary muscle giving rise to ciliary astigmatism. In cases of corneal astigmatism the ciliary muscle may contract partially, and by the production of a ciliary astigmatism exactly opposite to the corneal, neutralise this, and the eye thus becomes emmetropic." I suppose that in effecting these partial contractions of the ciliary muscle centres (lowest I should imagine) must be concerned. It becomes, however, a question whether there is not, besides a normal corneal astigmatism, a normal ciliary astigmatism; if there is, then, the ciliary muscle is not a pure sphincter. There are doubtless degrees of sphincters; the larynx is a sphincter, but a very complex one.

(2) Putting forth the arm and hand up to an object is certainly an act of locomotion, one concerned during estimation of distance within reach; during arrest of such a locomotor movement by what we call an external object we have the sensation resistance. Such locomotor movements are symbolised by converging, &c., movements of the eyes, there being at the same time alterations in the irides and ciliary muscles. It is obvious that activities beginning in the highest centres for such locomotor movements are the physical bases of Will (speaking for the moment of Will as a separate faculty and of its physical basis as distinct from that of the other "faculties").

(3) We must distinguish between height of evolution and degree of

the least organised, the ever organising. But Evolution is not a necessary or inevitable or "even" process; it is not one to be accurately symbolised by what is called Involution in Algebra. It depends on conditions.(1) As a whole, the Lowest Level of Evolution is the most organised level, and, as a whole, the Highest Level is the least organised level (we neglect the Middle Level). But there are, I submit, in the Highest Level some nervous elements (physical bases of the Constants) which are more strongly organised than any elements of the Lowest Level. The cardiac centres are the most strongly organised of all centres on the Lowest Level of Evolution; they "hold out" in deepest coma. But my hypothesis is, that those elements in the Highest Centres which make the physical basis of the Time Constant are more strongly organised than the lowest cardiac centres. I urge this although I am suggesting that the lowest cardiac centres are the centres out of which the physical basis of the Time Constant has itself been evolved (organismally, racially, and individually). So now we say that the physical basis of the Time Constant (and so of the other Constants) is of nervous arrangements which are the most Simple, and the most strongly Organised of the nervous arrangements not only of the highest but also of all centres.

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perfection of evolution. The lowest centres are most perfectly evolved, most organised, but they are least highly evolved; the highest centres are least perfectly evolved, least organised, but are most highly evolved. High organisation is popularly used as synonymous with great complexity, speciality, &c.; as thus used, a man has a more highly organised brain than a dog. But I use the term organised in its strict meaning, and doing so I say that the highest centres are the most complex and special of all, and at the same time the least organised of all; and I should say that a man has a more complex, &c., brain than a dog, but one much less organised. The highest centres, because they are least organised, are the most modifiable. They are the least automatic.

(1) The following quotation from (an Appendix to) Spencer's *First Principles*, p. 574, is important in several ways. "The doctrine of Evolution, currently regarded as referring only to the development of species, is erroneously supposed to imply some intrinsic proclivity in every species towards a higher form; and similarly, a majority of readers make the erroneous assumption that the transformation which constitutes Evolution in its wider sense, implies an intrinsic tendency to go through those changes which the formula of Evolution expresses. But all who have fully grasped the argument of this work will see that the process of Evolution is not necessary, but depends on conditions; and that the prevalence of it in the Universe around, is consequent on the prevalence of these conditions; the frequent occurrence of Dissolution showing us that where the conditions are not maintained the reverse process is quite as readily gone through."

The next hypothetical assertion is that the elements of the physical basis of the Time Constant (and of other Constants) are of all nervous elements the most independent. In the process of Evolution (organismal, racial and individual) they have become independent of the lowest centres out of which they were slowly evolved. In other words, they have become quite "detached" from those lowest centres. My speculation is that they are part of a further evolution of those nervous arrangements which at one time, far back in the history of life, were for (1) regulating the heart in its menial work, which (2) formed the physical bases of incipient or rudimentary and very general emotions, and which (3) constituted the physical basis of some vague, and so to say "Inconstant Constant" of Time, the three things being scarcely differentiated in the creature's rudimentary highest centres. In process of evolution (the highest centres becoming more evolved and more "detached" from and independent of the lower, Section XIX.), elements regulating menial work would become differentiated from those serving during increasedly complex emotion, &c. But it was suggested in the earlier part of this Section and in Section XIV., that in the highest centres (we mean now highly developed highest centres), the representation of the heart, *as an organ doing menial work*, would be almost a "vanishing point." The suggestion I now make is that those elements of this (what was once this) kind of representation, ceasing to have the duty of regulating the heart as a pump (having become almost completely detached from the lowest cardiac centres), would, *pari passu* with Internal Evolution, gradually come to be the physical basis of the Time Constant. And the further hypothesis is that the differentiation from the rudimentary highest centres to the developed highest was such that the directive elements of the undifferentiated nervous arrangements representing the heart (in the three ways at once) became especially the physical basis of the Time Constant, and that the inhibitory nervous elements came to enter especially into the physical bases of emotions. For this reason, I suppose the heart's systole to be the part represented in the physical basis of the Constant. If, as I suppose, that basis has become quite independent of, and entirely detached from the lowest cardiac centres, "represented" is, of course, strictly speaking, a misnomer.

So now, recapitulating, the supposition is that the

physical basis of the Time Constant (and so of the other Constants) is of nervous elements in the highest centres which are the most Simple, and the most strongly Organised. They are the most Independent and most autonomous of all nervous elements, having become completely "detached" from the lowest centres out of which they have been evolved ("have forgotten their origin").

We make further hypothetical assertions. The nervous elements of the Time Constant are the most perfectly or most simply rhythmical acting (perfect and most simple rhythm is the succession of the same events at exactly equal intervals). Being most strongly organised they are the most automatic, and this is saying that they are the most self-acting, and also that they are most unmodifiable in their way of acting. They go on in their own way independently of external sequences.

We spoke (Section XIII.) of the *wide* representation of the heart in the Middle Centres, and hypothetically, of their wide representation in the Highest Centres. We now venture to say that the nervous elements of the physical bases of the Constants are most evenly represented in the highest centres—that they are present in an equal degree in every unit of the highest centres (at least in those of the anatomical substrata of subject consciousness). As they are the most organised elements, they are the "physiological bottom," or basis, of those units, the physiological bottom of Mind (properly, of the physical basis of mind).

SECTION XVI. *General Remarks on Constants.*—The physical bases of the other Constants (Space, Mass (force) and Weight) are *mutatis mutandis*, similarly explicable. (1) There is great virtue in an "if," but *if* the account given of the physical basis of the Time Constant be correct, there is no difficulty in seeing what are the physical bases of the other Constants. Of course it is an arbitrary proceeding to consider the Time Constant separately from the other Constants; their relations to one another will be spoken of later.

There is an important qualification of, or rather, addition to, what has been said. We have spoken of the physical bases of the Constants as being present in the cerebrum (the highest cerebral centres). I submit, that the physical bases of all of them are largely present in the cerebellum

(1) No doubt there are other Constants as was in effect stated when (Section XIV.) speaking of the first kind of representation of the heart as a mass of tissues with all other tissues in the highest centres.

also. Anyone who thinks with me that both Ideation and Perception (Section I.) are objective (that they are different degrees of objectivisation) and who further agrees with me as to the kind of difference of degree (1) (triply-compound degree) will see at once the great significance of the presence of the physical bases of the Constants in the cerebellum. For I suppose that the current doctrine is that the highest cerebral centres are alone engaged and but slightly engaged (slight, but wide, discharges limited to them) during Ideation, whilst it is indubitable that, during Perception, they are more strongly engaged with all Lower motor centres of the cerebral system and that at the same time all orders of cerebellar centres are engaged. On this matter I shall speak later. I now use popular language and say that during perception (external sequences) we have knowledge of the "actual time" (as if there were, and there is not, the same time for everybody to be called *the* external time) and during ideation (internal sequences) of "ideal time" (rate of succession of our own ideas). I use this popular language "without prejudice."(2)

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(1) I shall speak of these differences in a future division of this article. I now quote from a paper I published in *Medical Press and Circular*, 1879 ("Psychology and the Nervous System"). "In brief, the greater the ideation the less the perception, the greater the perception the less the ideation; greater or less in the triply-compound degrees of (1) differences of degree of faintness and vividness of the images particularly constituting the mentation of the moment; (2) differences of degree of association of these images with already organised, and of degree of association with now organising images; and (3) degrees of feeble and strong reference to the environment."

What are called Images are some objective states "come out of" (in Perception "forced out of") "Subject Consciousness." The (1) faint, &c., images of ideation are as certainly objective as the (1) vivid, &c., images of perception. Ideation always precedes perception, although perception does not always follow ideation. The doctrine stated in the above quotation does not involve Crude Realism, as the mere word image might suggest to some readers. Nor is it pure Idealism. I adopt Spencer's doctrine of Transfigured Realism.

(2) Perhaps I ought here to make more explicit acknowledgments of my debt to Spencer than I did in the preliminary. I would gladly say that there is nothing of importance in the foregoing which I have not taken from him, were it not that it may very well be that he would find nothing of importance in any part of this article. I am almost ashamed to mention his name in connection with my imperfect and, I doubt not, very crude exposition of my borrowings from him. All the more, as very likely he would not approve of the detailed application I have made of some of his doctrines, when trying to show what is the physical basis of the Time Constant. It is safer and more respectful for me, his disciple, to give him no particular acknowledgment.

SECTION XVII. *Subject-Consciousness and its Anatomical Substrata—Pseudo Explanations of Psychical States.* —To give an account of the Anatomical Substrata of Subject-Consciousness, even supposing it was correct and thorough, is not to give an explanation of subject-consciousness in physical terms. I have (Section V.) repudiated all such "explanations." Let me illustrate by a case of Object-Consciousness. Suppose that I could see into a man's brain, and could give a correct and thorough account of what went on in it whilst he was having the colour red (thinking of a red object), that would be no sort of explanation of the (his) colour itself, but only of its physical concomitant. I now return to Subject-Consciousness.

In speaking of the Time Constant I have been speaking of a fragment artificially torn out of Subject-Consciousness, and have been only dealing with the anatomical basis of that fragment, have been speaking of things physical only. I have always used the expression "*physical basis* of the Constant Time," thus implying that the Constant itself is psychical. But now comes the question "Can we speak of the physical basis as having, I do not say a psychical 'side,' but as having a describable psychical 'side'?" The Constant is an integral part of the unit Subject; and it is by an artifice that we deal with it separately as we shall continue to do. But, doing so, the Constant is not describable in the same way as *states of* Object-Consciousness are. Although, for want of a better name, I say *Time* Constant, yet, as Constant is meant to imply, it is that by which Time, in the sense of successions of our objective states, is known. As already said it, with other Constants (their physical bases that is), make up the physiological bottom of the anatomical substrata of Subject-Consciousness. The physical basis of the Time Constant is the most organised, most unchanging, and is of most simple rhythm (the "physical absolute" so to say), and is that to which all less organised, more changing, and less rhythmical, is relative.(1) And how could we descend into the depths of our nervous system to ascertain what is the nature of the psychical correlative of the activities of the physiological bottom? If we could we could only describe that correlative psychical in terms of Object-Consciousness, which would be a pseudo-description of it. Thus, what I have

(1) The more organised is always a Constant to the less organised.

called the Time Constant is not itself in Time; it is that by which time (successions of our objective states) is possible. The Time Constant is not definitely describable in any terms of our psychical language. Looking at the matter in a rough popular way, everyone would admit that from perfect, unchanging, persisting, &c., rhythm, or say succession, the idea of succession itself would never arise. The Constant by itself is nothing.

Although I continue to use the term Time Constant, yet time or rather times (or successions) are objective states; they are successions of our own images; whether the images are "internal" as in Ideation, or "external" as in Perception, makes no difference as to their being objective; the images we call ideas ("internal") are feebly "projected," those we may call percepts ("external") are strongly projected. (See foot-note Section XVI.) Just as the Constant by itself is nothing, so these successions by themselves are nothing. As said (Section X.) there could be no Objective sequences for us, Subject, unless we ourselves were going on at some rate independently of, and so to say "out of," those objective sequences.

Green ("Proleg. Ethics," p. 55) writes: "The relation of events to each other as in time implies their equal presence to a subject which is not in time. There would be no such thing as time if there were not a self-consciousness which is not in time." We say again that the Time Constant being (subject) the standard of times, is not itself Time. It is that by which there are times or successions of images (objective states) for us. There is no entity Time — *the* Time — which is common property. Each person has all the time there is *for him;* and that is no entity for him. There is nothing more than the succession of *his* images (objective states) in relation to *his* unchanging Time Constant, which Constant is an artificially separated part of him, Subject.

SECTION XVIII. *On "Prolongation of Time."*—In some dreams and in some morbid states there is what is called Prolongation of Time. This is sometimes explained as being owing to a more rapid succession of psychical, with correlative nervous states; no doubt there is in those cases this more rapid succession. The cases are examples of Shallow Dissolution of the highest centres, the level of Evolution in these centres being correspondingly high. Upon Dissolution, especially when rapidly effected, there

is greater rate of activity on the lower, but *then* highest, level of Evolution remaining, and correlatively there is a more rapid succession of mental states. But such psychical states, even in dreaming, are objective, and there could be no knowledge of the succession at all if there were not some Subject Standard (or Constant). If it be said that the physical basis of the Time Constant changes proportionately there would be no difference; time would not be "prolonged."

I have spoken of the Time Constant as being unchanging. But most unchanging in regard of that to which all other changes are relative is the same as unchanging. Time is "prolonged" in the cases spoken of, because in the midst of increased changes something, a Constant, remains unchanged, or cannot be known to change in its rate of activity.

SECTION XIX. *On Detachment and Independence of the Highest Cerebral Centres and on Internal Evolution.*—I have spoken (Section XV.) of the physical basis of the Time and, inferentially, of the other Constants, as having become completely detached from and quite independent of the lowest centres out of which they have been evolved. I now make some general remarks on degrees of detachment, and on degrees of independence of elements of the highest centres.

As evolution, both in the race and in individuals, progresses, the highest centres not only gradually develop (become increasingly complex, &c.), but become more and more detached from, independent of, the lower centres out of which they have been evolved. The detachment, or independence, is never complete, except hypothetically, in the cases of Constants. There are degrees of detachment and of independence. By the double process of increasing complexity and increasing detachment of the highest centres, we gradually "get above" our lower, mere animal selves. Our highest sensory and highest motor centres (together the organ of mind) can energise to a large extent, independently of the lower, out of which they have been evolved, and by aid of which they have been developed. Spencer writes ("Prin. Psych.," vol. 1, p. 546) ". . . manifestly, the more extensive and more intricate the central plexus [highest centres] grows, the more *detached* may these [what under their subjective aspects we call feelings and ideas] become from the actions—the more may the impres-

sions produced by things and relations reverberate through the nervous system—the more may there arise trains of thought." Fiske writes ("Destiny of Man," p. 46-7) ". . . there is no consciousness except when molecular disturbance is generated in the cerebrum and cerebellum faster than it can be drafted off to the lowest centres. It is the surplus of molecular disturbance remaining in the cerebrum and cerebellum *and reflected back and forth among the cells and fibres of which these highest centres are composed, that affords the physical condition for the manifestation of consciousness.* Memory, emotion, reason and volition begin with this retention of a surplus of molecular motion in the highest centre." The part I have italicised is very important.

Not committing Mr. Spencer or Mr. Fiske to any crudities of mine, I would thus illustrate. Thanks to the protection of the highest sensory centres by the lower sensory centres (which are "resisting positions," as well as "reservoirs of energy"), they can energise uninterfered with by the present environment. Again, thanks to the resistance of the lower motor centres, the sister highest motor centres can act without producing peripheral reactions; the muscular periphery is "protected" from the highest motor centres. Here we have the physical conditions answering to the differences between vivid and faint states of object consciousness. When the highest centres are acted on from the periphery, and are thus put in strong activity, they react on the periphery and, taking a case, there is correlatively perception. But they can act alone and then there is correlatively ideation not passing into the further stage of objectivization, which is perception.

Thanks to the "protections," there occurs Internal Evolution in our highest centres; we can have combinations never actually experienced ("ideal combinations"), as indeed we obviously have when dreaming, and certainly during much of our waking lives. I here give a quotation from my Croonian Lectures, *British Medical Journal*, April 12th, 1884. "There is something more: there is what I will call "Internal Evolution, a process which 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-centres being resisted by the middle and lowest centres; in such case (sleep, reverie, reflection, &c.), 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)."