IV.—A CONTRIBUTION TOWARDS AN IMPROVEMENT IN PSYCHOLOGICAL METHOD. (III.)

(Conclusion.)

BY W. McDougall.

REMARKS ON THE NATURE OF NEUROSIS IN GENERAL.

Hitherto, I have dealt with only the simple motor reactions of the nervous system, and before attempting to deal with more complex functions of the mind, it is necessary to say something of the probable nature of neurosis in general. So far as we know, the nervous system consists wholly of distinct units, the neurons; *i.e.*, the nerve cells and their processes. The neurons are in groups and sub-groups, the members of which are in functional continuity of varying intimacy, through proximity of the terminal twigs of the processes of one with similar twigs or with the cell bodies of others. It is commonly agreed that a simple reflex action consists in the passage of nervous impulses through a group of such neurons arranged in a more or less serial manner, leading from the afferent to the efferent nerve fibres. It is a not improbable assumption that this is the type of all neurosis; that the neurosis concerned, in the most complex mental activity, consists also of the passage of an extremely complex series of nervous impulses, through extremely complex groups of neurons from the afferent towards the efferent side; the impulses being variously reinforced in their passage through the cell bodies. According to this view all mental process is but a complication of motor re-action to stimuli affecting the sense organs; the neurosis concerned in cognition and reasoning is essentially conative in character, all the neural impulses pass onwards towards their natural goal, the nuclei of the efferent nerves. In man, a very great complication may be assumed to have resulted from the acquirement of speech: a very large part of the nervous impulses find their goal in the motor speech-centres without actually determining movements of the organs of speech. It is when the nervous impulses find their natural goal in appropriate motor innervation that they rapidly become organised on repeti-

tion, and lose their conscious accompaniments. This is well illustrated by our first example of the morning call. In this case, there are two distinct motor outlets for the impulses excited by the sounds, namely, the innervation of the speech organs, and that of the muscles that raise the body. As the response becomes automatic, the energy of the nervous excitement becomes drawn off more and more into the tracts leading to the speech organs, for on each repetition of the answer the afferent impulses from the muscles used will tend to organise still further the tracts concerned; and so the nervous excitement, finding a natural outlet in the movements of the speech organs, soon ceases to pass into the tracts leading to the getting-up muscles. It is, I think, a fair assumption in the case of our last example, that if the waiter were constitutionally lazy and in the habit of answering calls with a simple 'Yessir,' and no other immediate movement, then he might answer 'Yessir' while continuing to sleep.

I have already made use of this assumption as to the general nature of neurosis, and I shall continue to do so in the following pages for the sake of convenience of description, since it seems to be well founded and highly probable.

If we adopt this view of neurosis, we must suppose that when neurosis is accompanied by psychosis, consciousness is determined by the passage of the nervous impulses along the whole or some parts of the tracts of neurons concerned, in whatever part of the nervous system they may lie. For I have already pointed out that the assumption that consciousness is generated in some particular part of the brain, whether in the pineal gland, the medulla oblongata, or the frontal lobes, is quite unfounded and unnecessary. Here I would point out that the evidence is all the other way. For all that we know of localisation of function in the cerebral cortex, and especially of those cases in which by a local lesion, such as a hæmorrhage or an embolus, the possibility of some particular form of consciousness is abolished, and of the phenomena of the epileptic aura, indicates that consciousness is immediately determined by neural processes, now of one, now of another part of the cortex. The phenomena of double personalities and of split-off parts of the self forming minor personalities indicate the same fact. For these cases are only explicable by the assumption that groups of neurons become functionally discontinuous with the rest of the nervous system, and form a separate minor nervous system capable of producing consciousness, and even some degree of self-consciousness.

**THE CONDITIONS OF OCCURRENCE OF CONSCIOUSNESS IN
TERMS OF NEURAL PROCESS.**

These considerations prepare the way for the attempt to describe complex processes of the mind in terms of neural processes, and to define more accurately than has yet been done the conditions of occurrence of consciousness in terms of those processes.

In making this attempt, I cannot do better than to begin by accepting without reserve the doctrine of noetic synthesis and apperception as laid down by Stout in the second volume of his *Analytic Psychology*. We read there that 'In the developed consciousness, the whole mind is more or less perfectly organised into a system of noetic units, in which partial apprehensions are subordinated to more comprehensive apprehensions, and these in their turn to others still more comprehensive'. The noetic units or syntheses are mental dispositions built up by apperception, a process by which every presentation is appropriated by some noetic unit. 'Apperception may be defined as the process by which a mental system appropriates a new element, or otherwise receives a fresh determination ;' it is the process by which 'products of past process determine and are determined by succeeding changes'.

As we have already seen, Stout avoids physiological considerations by adopting the hypothesis of psychical dispositions. The latter seems to be the same thing as a mental system in a passive state, and Stout explicitly states that it may be regarded as a physiological fact. If we attempt to express this doctrine of mental systems and apperception in terms of neural process, we shall find that there is implied in it the proposition whose truth I am endeavouring to establish, namely, that consciousness accompanies only the process of establishment of new connexions among neurons. For a mental system in its passive state is in its physiological aspect a grouping of neurons forming a more or less complex path, by which afferent nervous impulses pass on towards their efferent goal in a manner determined by the nature of the path. The activity of a mental system consists in the passage of nervous impulses through it in this manner. The mental system has been built up from a much simpler nucleus, probably a simple reflex nervous arc by repeated apperception, 'the process by which a mental system appropriates a new element, or otherwise receives a fresh determination'. In terms of neural process, apperception must be conceived as an extension and further complication of a mental system, by the incorporation into it of other neurons and systems of

neurons, so that the complex path no longer leads to quite the same, but to a modified efferent outflow. This process seems to be determined in two ways. It may be by the presence of some novel element in the afferent group of impulses, for whose reception and transmission the system is adapted, so that the system is no longer perfectly adapted for their transmission; impulses then overflow the physiological barriers of the system, spreading over to neurons hitherto unconnected with the system; the physiological barriers once passed are destroyed or partially destroyed, there is established a connexion between the system and the neurons newly affected, the latter are incorporated into, and henceforward form a part of the former,—the mental system has appropriated a new element. The other way in which a system may receive a fresh determination is by the establishment of inter-connexions with other systems, through their excitement contemporaneously, or in close proximity in time, *i.e.*, by association by contiguity in time. For there are good reasons for believing that the physiological barriers of a system are not absolute; that when a system A is excited, although the main current of the flow of impulses passes through the nerve-paths constituting the system, yet a fainter excitement spreads from the system through a large area of the whole nervous system. Further, we must believe that if any other system B, forming a part of this faintly excited area, be excited at the same time or immediately afterwards, then from it also there spreads a faint excitement through a large area and passes with especial ease and force along the tract by which the faint excitement has spread from A to B. This tract is then more permeable in the future, and any excitement of A tends to spread to B also, and conversely. Between the two systems A and B there is thus established a connexion, and they form now a single, more complex system, of which A and B are sub-systems. The motor re-action to which the excitement of this new system leads, is the resultant of the re-actions of the two systems, and may appear as a more complex re-action, showing the features of both the constituents, or it may appear as a partial abolition or inhibition of the one by the admixture of the other, according as they are similar or antagonistic in nature.

Whether apperception is ever determined in the former manner, without some previous effect of the latter kind, or whether in fact the two processes are not essentially similar in nature, is an interesting but difficult problem, the consideration of which is not essential to the purpose in hand.

By relatively simple mental systems, our ordinary automatic movements are carried out. The paths have been organised by frequent repetitions of similar series of afferent impulses, each of which, in so far as it was different from its predecessors, determined apperception (the extension and complication of the system by the establishment of new connexions), and so modified the motor re-action ; while the part of each series of impulses that was coincident with its predecessors ran in the paths already organised. In purely automatic movement, simple or complex, the series of afferent impulses are all coincident with previously experienced series, they run to their motor goal through well-organised systems, there is no making of new nervous connexions, no apperception, no consciousness. In learning any complex action, there is at first much varied attention, first to one part, then to another, and to the impressions from them ; there is much consciousness, continual apperception, *i.e.*, continual organisation. Then as parts of the total complex movement become automatic, while others still require attention, the movement is in part carried out by organised paths or sub-systems, without further apperception and without consciousness, and in part by sub-systems that are still undergoing fresh determinations, still involving apperception and consciousness. In every volitional movement, as distinguished from purely automatic movement, there are concerned neural processes of these two kinds ; a large part of them are automatic, proceeding to their motor goal by organised sub-systems, while some pass partly by new or relatively new paths, and in so doing organise them, *i.e.*, there is apperception, attention and consciousness.

Turning now to cognition, and keeping its conative aspect before us, we must recognise two kinds of process concerned in any apprehension of an object. The part of the object presented in consciousness is but a part of an implicitly apprehended whole. The implicit apprehension consists in the excitement of a mental system corresponding to the previously presented parts of the object ; the impulses excited by these parts pass to their appropriate motor goal by well-organised paths without exciting consciousness. But any novel elements in the object excite impulses that find no such organised paths, they determine an extension of the system by incorporation of new elements ; there is establishment of new connexions, *i.e.*, apperception, and with this establishment of new connexions consciousness is aroused, a consciousness of all the novel elements that are thus apperceived.

Thus, to make use once more of the much-used orange, when I see an orange and go to take it up, I am conscious of its general shape and colour, and chiefly of its position, but there is much besides that is implicitly apprehended. If I take it in my hand, the strength of the muscular contractions, involved in raising it, is accurately pre-adapted to its weight, as shown by the fact that if it is heavier or lighter than oranges usually are, I fail to move it in the first moment, or it flies up unnecessarily high. The weight of the orange was implicitly apprehended, but I was not conscious of it. It is not, as Spencer seems to imply in discussing this example, that I consciously expected in a dim way a certain weight. It is merely that a mental system corresponding to oranges in general has been built up in the brain, and when I put out my hand to take it up, nervous impulses are appropriately co-ordinated in strength and direction by a sub-system which has been built up by previous apperceptions of the weight of oranges; the excitement of this sub-system constitutes the implicit apprehension of the weight of the orange.

I do not, for the purpose in hand, make any distinction between the afferent nervous impulses that lead to the perception of objects in the external world, and those from the muscles, joints and other structures that are concerned in the carrying out of movements. The afferent impulses concerned in the carrying out of an automatic movement, or those parts of a complex volitional movement that go on automatically, are implicitly apprehended in exactly the same sense as those originated by the parts of a complex external object that though not attended to play a part as the 'fringe of thought' in determining the whole mental process. It is only when series of afferent impulses are frequently repeated with but very slight differences, and without fresh determination of the mental system from within, that the apprehension of them becomes wholly implicit, that the mental system excited becomes completely adapted to transmit them to their appropriate motor goal, without any fresh apperception, without any consciousness. These conditions are seldom realised except in the case of rhythmically repeated movements, such as those of walking and cycling. When we look at a complex object there is continual apperception, for such an object contains many parts in many different relations to one another, and it can scarcely be presented twice without change in the relations of its parts, either to one another, or to its surroundings as they affect the sense organs, or without some change having taken place in the mental system concerned; hence as Stout says: 'In almost every moment of waking

life, an apperceptive process is taking place. Whenever an object is attended to, the presentation of it is apperceived.' It is instructive in this connexion, to try to attend continuously to a minute black spot without distinguishable parts on a smooth white surface. In this object there is little or nothing to be apperceived. We can only remain intermittently conscious of it by apperception of its relations to any other distinguishable objects in the field of vision or by continually bringing it into relation with some presentation of self, a process in which language seems to play a large part. To remain conscious of the simple point itself would be inconsistent with the very nature of thought ; for thought is a process of continual transition, to arrest its flow but for a moment is to destroy it.

In every complex object that affects the sense organs, we must distinguish three kinds of parts. Firstly, there are parts that are undiscriminated because there is no mental system corresponding to them ; they fail to affect mental process in any way ; they form the undifferentiated part of the objective continuum, a part that may be said to be in the pre-conscious stage as regards the particular mind that they fail to affect. Secondly, there are those parts which are apperceived, to which we attend, of which we are conscious. Thirdly, there are those parts that, though not attended to, are implicitly apprehended ; they may be said to form the post-conscious part of the presentation-continuum.

Apperception then is one aspect of the attention process, and consciousness occurs only in association with apperception, *i.e.*, it occurs only as the immediate correlate of the process of establishment and organisation of new connexions between neurons and systems of neurons.

I have said that this conclusion is implied by the doctrine of apperception and noetic synthesis, as put forward by Stout, and I will here make a somewhat lengthy series of quotations to justify this statement, and so lend weight to my conclusion. In vol. ii., p. 3, we read, 'The antithesis between noetic synthesis and contiguous adhesion is brought out in the clearest light in the passage of attentive into automatic process. In proportion as automatism supervenes, association becomes substituted for thought-control, and in the final stage completely supplants it ;' on p. 9, 'It is not enough that the residua of previous impressions should be re-excited. Their re-excitement must bring with it a peculiar modification, resulting in a new growth both mental and physiological ;' and on p. 40, 'When we consider a noetic synthesis not merely as involved in this or that conscious process, but

as a mode of mental grouping which persists as a disposition when it has ceased to operate in actual consciousness, we have the idea of an apperceptive system. It is through the gradual growth and differentiation of such systems that new phases of noetic synthesis arise.' On p. 73, in treating of relatively automatic movements he writes, 'They are automatic parts of a process which as a whole involves concentrated attention. Attention is engrossed by a series of fluctuating conditions and by the nature of the end to be attained. But the adaptation of movements to the perceived conditions takes place in a more or less automatic way ;' and on p. 87, in treating of conation, 'It is separately felt as such, when and so far as the special conditions of its partial revival vary in a way which is not thoroughly familiar, and so call for a re-adaptation by relative suggestion or otherwise, which cannot take place in an automatic manner'; on p. 112, 'The process of apperception substantially coincides with that of attention. . . . The attention-process, as we saw, is characterised by systematic unity and relative novelty. Under the head apperception, we are especially concerned with the relations of the new to the old, in so far as it gives rise to modification of the old. We consider the whole process as one by which the mind grows ;' on p. 113, 'The need for the apperceptive process and the stimulus to it lies in the initially foreign and alien nature of the new element, and the consequent antithesis between its disturbing novelty and the internal self-development of the system'; on p. 115, 'The whole itself is nearly always presented in the way of implicit or schematic apprehension. To say nothing of other difficulties, the narrowness of consciousness forbids that it should, at any moment, be presented in the fulness of its details. Hence a mental system, even when it enters into conscious process, always remains to a very large extent beneath the threshold of consciousness ;' on p. 118, 'Where attention is not present, there is no apperception, but mere assimilation. . . . Assimilation there must always be, inasmuch as the existence of a given experience coincides with the re-excitement of some pre-formed disposition. Thus in automatic actions, the impressions which guide us are all assimilated, but not apperceived. Whenever, through habitual exercise, an organised group of psychical dispositions has become so pre-conformed to a special class of familiar experiences, that it assimilates them with a certain degree of ease and rapidity, apperception becomes needless. There is the less need for it, the more perfect is the mental pre-adjustment.' And on p. 122, Stout himself deals in physiolo-

gical process, instead of psychical dispositions, for he writes, 'Even when the controlling guidance of a central thought ceases to operate as a unifying principle it may leave behind it, as a substitute, a nervous arrangement, which fulfils an analogous function independently of consciousness'.

COMPLETION OF THE ANALYSIS OF A SIMPLE CASE OF EXPERIENCE.

It is interesting to return now to the analysis of the spoon-game, the instance that was chosen as a simple case of experience and the type of all mental growth, and to complete it by the application of the doctrine of apperception. We saw that the total result of the game on my mind or nervous system was to establish an automatic re-action to a certain feature of the objective continuum hitherto undifferentiated, namely, the peculiar relation between a stimulus A, constituted by a particular voice speaking my name into my left ear, and the particular stimulus B, the heat of the spoon on my cheek. On the first occurrence of A, it occasioned, in virtue of its character merely as a loud sound in my left ear, the excitement of a mental system long ago built up by apperceptions of many loud sounds, and the excitement of this system leads automatically to the turning of my head to the left; the stimulus in its character as a loud sound is in the post-conscious stage, the re-action is reflex or instinctive. But the stimulus has other features; it is apperceived by mental systems in higher levels of the brain, corresponding to the sound of my name, as my name spoken by a particular voice; the excitement of this system, with the accompanying apperception and consciousness, leads or tends to lead to some such motor re-action as the saying 'Yes? Well! what is it?' But as yet there is no mental system corresponding to the peculiar relation between A and B. When B occurs there is in a similar way a post-conscious re-action, in the jerking away of my head, to B in its character merely as a violent stimulus to the side of my head; while at the same time B in its character as a hot object on a certain spot of my cheek, is apperceived by a system higher in the brain; I am conscious of B as such. Then owing to the contiguity in time of the excitement of these two systems, apperceptive of A and B respectively, there is established a connexion between the two, each is modified by the other, and this mutual modification is the apperception of the causal relation between A and B, and there is differentiated a new sub-system corresponding to this relation. This rela-

tion now enters for me upon its conscious stage of existence. On the recurrence of A the new sub-system apperceives it as A-related-to-B, and leads to a new motor re-action, consisting in a modification of the one re-action by the other, a resultant of the two. When this new object A-related-to-B has been presented several times, with but very slight variations in its constituent parts, the elements of novelty in it disappear, consciousness diminishes, and soon the sub-system leading to the new motor re-action becomes completely organised, the relation of A to B enters for me upon its post-conscious stage, and the whole process goes on automatically, while attention is directed elsewhere. There seems to be another principle at work also, one that was noted in connexion with the analysis of the morning call and the automatic response, the principle, namely, of the condensation of nerve paths, the tendency for all the energy of a stimulus to be drawn off into one of two alternative motor centres. For A ceases to be either apperceived or implicitly apprehended, as my name spoken by a particular voice; the corresponding mental system that leads to the response 'Yes? What is it?' does not become organised, but simply ceases to be excited.

THE PREMISES OF THE PRECEDING ARGUMENT GENERALLY ADMITTED.

I have already attempted to show that my thesis as to the occurrence of consciousness is found to be contained in Stout's doctrine of apperception, as soon as we translate it into terms of neural process, and I wish to point out that the main premisses of the argument are very generally accepted. What I have said of the more definite organisation of the paths of the lower parts of the nervous system, and of the greater complexity and possibility of establishment of new connexions in the higher parts, is well put in the following sentences by Waller:¹ 'The higher the brain the greater the mass of the formed formable material. But the further the differentiation shall proceed of formable material, the further it must already have proceeded of formed material. The higher brain must include subordinate highly specialised and economically working mechanisms—guiding parts.' 'And yet the further the brain has developed within the span of life of its possessor, the greater the differentiation of function and of organ out of the mass of formable material.' 'The

¹ *Brain*, xv.

higher the brain the less the fixity, the older the brain the greater the fixity.' And again, 'At the lowest level the representation is most definite and fixed, the canalisation of conductors is most closed, the differentiation of the central organ is most complete. At the highest level the representation is least definite and most fluctuating, the canalisation of conductors is most open, the differentiation of the central organ is least complete.'

James gives expression to the same truth when, after defining instincts as automatic re-actions of the nervous system, he writes that man differs from animals in having not fewer but more instincts, 'though the animal richest in reason might be also the animal richest in instinctive impulses too, he would never seem the fatal automaton which a merely instinctive animal would be' (vol. ii., p. 393).

The fact, that consciousness accompanies novel and relatively novel affections or activities of the brain and dies away when these activities are repeated, is also fully recognised. Thus Wundt: 'Jede Uebung besteht in der Mechanisierung ursprünglich mit Bewusstsein geübter Willenshandlungen'.¹ So also Bain in a recent article in *MIND* (vol. iii.). 'They (the intellectual trains) also become conscious according as Habit has not supervened to give them a mechanical or automatic flow'; and again: 'Actions properly voluntary lose their character under two extremes or gradations—on the one hand, their shading into the Reflex, and on the other hand, their passing into the Habitual. In both cases, they part to a corresponding degree with their conscious character, as is seen by their giving room for other occupants of the conscious area.' Without professing to understand in what sense the Reflex and the Habitual are two extremes, I regard these sentences as containing a very frank recognition of the unconscious mental constituent on the part of a leading exponent of pure psychology.

But although these two great groups of facts are thus fully recognised, their significance when considered together and in conjunction with the general character of neurosis, has, so far as I know, never been fully and explicitly pointed out as giving the clue to the conditions of occurrence of consciousness. In face of them and of all the considerations adduced above, it must, I think, be admitted that the essential condition of the occurrence of consciousness is the making of new nerve paths, the establishment of new functional connexions between neurons.

¹ *Philosophische Studien*, p. 378.

SOME COROLLARIES OF THE ABOVE PROPOSITION.

It will be seen that, accepting the principle of continuity, it is a logical inference from this doctrine that all adaptation of nervous re-action to environment in the past has been accompanied by consciousness; that the organisation of the simple reflexes and instincts of the lower animals was accompanied by a consciousness of a very low kind; that in man the reflexes of the cord and lower parts of the brain were organised long ago, before man was man, and that some low form of consciousness accompanied their organisation, just as in the adult there are automatic habitual actions carried out by nerve paths that were organised during childhood with an accompanying consciousness.

It is a further inference that, under two conditions, consciousness would become impossible, either if an animal should become perfectly adapted to its environment, or if an individual should have lived so long that all the parts of its nervous system had become mapped out into well-organised paths of automatic reaction. For in the case of an animal perfectly adapted to a limited environment, all its movements would be automatic, all apprehension would be implicit, all its mental processes would go on without consciousness. There would be no apperception, no establishment of new relations among nerve paths in response to novelties in the environment, if there were no such novelties, if for every possible combination of stimuli there had been organised a mental system leading to an appropriate motor re-action. It seems probable that such a state has been almost reached by such lowly animals as *Lingula*, a *Brachiopod*, that seems to have persisted as a species unchanged from Pre-Cambrian times up to the present day. Living in the deep sea, such an animal is exposed to an environment of very limited complexity. It may be reasonably supposed that its nervous system is completely organised to carry out automatically its few motor re-actions to the comparatively simple impressions made upon its sensory nerves.

But there is little reason to hope or fear that we shall attain 'Nirvana' by this route. Our environment seems to be infinitely complex and varied; and in the past, natural selection, or whatever forces have determined evolution, seems to have so worked that while adaptation has proceeded by establishment and organisation of new nervous connexions, there has been at the same time a continual increase in the number and complexity of new neurons (those of level 4 in our scheme), affording possibilities of the forma-

tion of new and more complex combinations of nerve paths, of more accurate, detailed adaptation to an increasingly complex environment. And it would seem probable that this multiplication of neurons has been, and will continue to be effected at a relatively more rapid rate than their organisation into fixed paths takes place, so that there are ever increasing possibilities of the establishment of new relations among nerve paths, and of a more intense and more varied consciousness. This must be the case in progressive species at least. The highest animal is not the one whose nervous system is most completely organised for re-action upon a limited environment, and in which consciousness no longer occurs, but the one whose nervous system affords the greatest possibilities of new adaptations, of new relations among nerve paths, and so of the most complex and intense consciousness.

ON PAINFUL CONSCIOUSNESS AND THE ACTION OF ANÆSTHETIC DRUGS.

There is one form of consciousness, and one only, which, as it seems to me, it may be proper to describe as 'Anoetic,' and that is the consciousness of pain in certain cases. Pleasurable feeling may be said to occur always in conjunction with healthy normal mental process; there is always some noetic element in the consciousness. Perhaps in painful feeling too, there is always some noetic element, some localisation or recognition of the pain as such or such. But certainly the pain itself may be very intense, while all other contents of consciousness are of very low intensity. By the one word pain, we denote both the sense of strain or of unpleasant tone accompanying the higher mental processes, and physical pain arising from violent stimulation of afferent nerves, or stimulation of nerves in certain abnormal states. Although these two things in extreme cases seem very different, yet they are commonly recognised as being essentially similar. The comprehensive formula for pain, given by Stout, seems to apply strictly to the former kind only. The formula runs: 'An activity which is thwarted or retarded, either by the presence of positive obstructions, or by the absence of co-operative conditions, or in any other conceivable way, is painful in proportion to its intensity and complexity'. And again: 'The antithesis between pleasure and pain is coincident with the antithesis between free and impeded progress towards an end'. We may apply this formula to the analysis of a state of acute vexation. When I am in this distinctly painful state I have a strong feeling of the

necessity for doing something, and yet nothing can be done. There is no appropriate outlet in motor innervation for the surplus of nervous energy excited; I make various violent purposeless movements and explosive utterances; I form rapidly, and as rapidly give up, various projects for immediate action, perhaps all impossible, and utterly inconsistent with one another. This may perhaps go on until I conceive the idea of something to be done to remove the source of vexation. At once the vexation disappears, as I set about giving effect to my idea, the nervous excitement finds vent in rapid and effective trains of thought and action. If we attempt to express all this in terms of neural process, we must recognise that the essence of the whole matter is the setting free of excessively powerful nervous discharges that do not run a normal course to an efferent goal. Instead of flowing through co-ordinated mental systems in an orderly manner to an appropriate goal, and setting up new relations between allied systems and sub-systems, the energy of the discharge is so great that besides flowing in natural paths, it breaks across the physiological barriers that demarcate the systems from one another in an utterly disorderly and unmeaning manner, having little or no reference to the paths determined by heredity and experience; hence the utterly disorderly, though intense consciousness, hence the incongruous ideas, the ineffective explosive movements, the general visceral disturbance of heart, respiration and blood-vessels. While there is a noetic element in the aroused consciousness, the result of apperceptive processes among the mental systems, of the passage of the nervous excitement across certain physiological barriers in an orderly normal manner, there is also the intense unmeaning element due to a similar process of passage across physiological barriers, but on a greater scale, and in a disorderly manner, and this is the painful or displeasing element.

In the same way, physical pain may be regarded as an intense disorderly consciousness accompanying the spread of powerful nervous impulses through large areas of the nervous system. The impulses are so violent that they break across the barriers that suffice to demarcate systems for currents of normal strength, and in so doing they arouse violent unco-ordinated motor re-actions, both visceral and somatic.

There may perhaps be distinguished two determinants of this disorderly form of consciousness: on the one hand, a disorderly, on the other, a too intense initial disturbance. In the case of painful mental activity we recognise the former

determinant of the painful element, in the excitement of systems that cannot work harmoniously together towards the production of a co-ordinated efferent outflow, the presence of conflicting ideas and tendencies ; and in the case of physical pain, we recognise it in the excitation of sensory end organs by unwonted stimuli, stimuli that lead to an unwonted set of afferent impulses, for whose reception there is no mental system prepared. Thus, any electric stimulation of the skin, being altogether unusual and unlike any other kind of excitation, is painful or disagreeable, even in its lowest grade of intensity. The other kind of determinant of pain, the too great intensity of the initial disturbance, is also capable of causing pain of both kinds. In the case of pain of mind (as it is commonly called) we have good evidence of this in the way that even pleasurable emotion may become painful through too great intensity. And physical pain seems to result from too violent stimulation of perhaps any afferent nerve. In both cases we may suppose that the nervous excitement is too great to be carried off by any co-ordinated system of nerve paths, that it breaks across physiological barriers on every hand spreading through unrelated mental systems in a disorderly manner, perhaps through every part of the nervous system, so provoking the characteristic display of violent purposeless motor re-actions, both visceral and somatic, and, when very intense, leading to the state of complete nervous exhaustion that we know as 'collapse'. It is significant that severe pain that persists usually sets up some rhythmically repeated motor re-action, such as the swaying of the body, the grinding of the teeth, the wringing of the hands, or the repeated utterance of some irrelevant phrase. The setting up of such a rhythmic re-action leads to a diminution or cessation of the pain ; a tract is established and partially organised, and by it the energy of the nervous excitement is partially drawn off, so that the breaking through of physiological barriers no longer occurs on so great a scale.

If this be a true account of the nature of painful neural process, do we not see here a physiological basis for the spiritual benefits of pain, that pious elders so delight to dwell upon ? The violent nervous impulses break across barriers that might never have been surmounted otherwise, and so make the first step towards the setting up of relations between mental systems that might have remained forever unrelated if the individual had lived a happy, painless existence. 'Happiness is dulness,' as George Meredith has somewhere written.

These remarks on the nature of the physiological correlate of pain lead naturally to the consideration of the nature of the action of anæsthetic drugs, such as alcohol, chloroform and ether. I will set down here an hypothesis as to the nature of their action which, while it seems highly probable, would, if it could be shown to be true, lend powerful support to my main thesis as to the physiological conditions of the occurrence of consciousness. All the facts known as to the action of these drugs seem to me to point to the conclusion that they tend to diminish and abolish functional continuity between the neurons, just as curari abolishes functional continuity between neuron and muscle fibre, and atropine that between neuron and gland cell.

In the first place, we know that the activity of the central nervous system is profoundly affected by the presence in the blood of such small proportions of these drugs as do not appreciably affect the conductivity of nerve fibres. And we know that the higher mental functions are abolished while the neurons, constituting the reflex arcs of the cord, are not appreciably affected. There are no grounds for believing that the chemical natures of the cells concerned in the higher and lower functions of the nervous system are essentially different.

But far more important is the fact that the functions of the parts of the nervous system seem to be abolished strictly in the inverse order of the degree of fixity of organisation of the nerve paths that subserve the functions. For, beginning at the bottom of the scale of functions, we know that the last functions to be abolished by these drugs are those of the respiratory reflex arcs, and it may fairly be assumed that those through which nervous impulses are passing in every moment of life, from birth onwards, are the most completely organised of all reflex paths. Earlier than these are abolished such pure reflexes as the corneal and those on which the tone of the skeletal muscles depends, and earlier still, such reflexes as lead to the quick withdrawal of a limb on sharp stimulation, and all such reflexes as are only of occasional occurrence, and approximate in type to instinctive actions. Pharmacologists describe the effects of these drugs on the nervous system in general terms, as the abolition of its functions in the order from above downwards, in a scale not very accurately defined. If we analyse the early stages of the effects of alcohol, we find that, just as in the case of the reflexes of the cord, the functions of the nerve paths of the cerebrum are abolished in the inverse order of their degree of fixity of organisation, the degree of intimacy of physiological continuity

between the constituent neurons. Recent experimental work by Kraepelin has shown that alcohol, even in doses so small as to produce no subjective symptoms, diminishes intellectual power and accuracy. The first well-marked symptom is a diminution of self-consciousness. It is notorious that a man when slightly under the influence will boldly do and say things that in his normal state he could not bring himself to do or say, owing to self-consciousness and the rapid imagining of himself as he would appear in the eyes of others. At the same time, and as in part the same process, his sense of general responsibility diminishes. Now self-consciousness of this sort is one of the most intense and varied forms of consciousness. It depends upon the repeated interaction of mental systems subserving the ideation of various aspects of self with very numerous other systems, as they are excited. This interaction involves a very great amount of that physiological activity which we have found reason to regard as the immediate correlate of consciousness, namely, the establishment of new or relatively new nervous connexions. In such mental processes there is involved a greater proportion of unorganised, as distinct from organised nerve paths.¹

In an early stage of drunkenness, the ruder, more primitive instinctive impulses, are apt to make themselves effective, because they are no longer controlled by the mass of partially organised mental systems that represent the social training and finer points of character of the individual. And in a further stage before consciousness is abolished, it is so much reduced that the person may repeatedly perform some such action as shaking hands, or the asking of some question, each time without remembering that he has gone through the same performance in the previous moment. Consciousness is, in fact, so low in intensity that on the morrow there may be no memory of even very extraordinary events that may have occurred during this period. During this stage all actions seem to be performed almost automatically, and the finer movements requiring accurate co-ordination and attention are no longer possible. In a slightly later stage consciousness seems to be completely absent, and even such instinctive actions as walking cannot be performed, owing to the inability to balance the trunk and co-ordinate movements; but the purely reflex element in walking, the rhyth-

¹ The excitement that so frequently accompanies the initial stages of the action of alcohol, is probably an entirely indirect effect, due to dilatation of the cerebral arterioles, and increased activity of the heart, together with the loss of sense of responsibility noticed above.

mic movements of the legs, is still possible, for if supported on either side the patient may walk fairly well. This is the initial stage of coma, and it is important to notice that even in a more advanced stage of coma, long after the abolition of apperception, attention and consciousness, some at least of the cortical neurons are still functional, those, namely, that form parts of well-organised mental systems; for it is possible, even in this stage, by loudly asking the patient's name, to elicit an appropriate response, and, as I have already pointed out, there is every reason to believe that speech always involves the activity of cortical centres. It must then be admitted that the abolition of function of the parts of the nervous system by these drugs, is effected exactly in the inverse order of the degree of fixity of organisation, of functional continuity of the nerve paths concerned.

Having regard then to the present state of the histological evidence and to the facts of the localisation of the action of curari and atropine, mentioned above, it seems highly probable that fixity of functional continuity depends upon the intimacy of the junctions between processes of the neurons and that these drugs act chiefly upon the junctions tending to abolish their conductivity for the nervous impulse. This view of the action of the drugs would afford a very satisfactory explanation of their analgesic action. For the increased resistance of the junctions between neurons, to the passage of the nervous impulse, means a strengthening on every hand of the physiological barriers. Hence these drugs tend to prevent that disorderly forcing of the barriers that seems to be the physiological correlate of painful feeling, so diminishing or abolishing both the pain and that widespread disorderly motor innervation, both visceral and somatic, which accompanies pain.

The phenomena of fatigue seem to point to the same conclusion. It has not been found possible to induce fatigue experimentally in such neurons as are accessible to direct observation, and the neurons of the lower reflex centres seem capable of great and long-continued activity without showing symptoms of fatigue. The functions of the nervous system seem to be affected by fatigue in just the same order as by alcohol and chloroform, *i.e.*, the more automatic the function, the more definitely organised the nerve path, the less readily is it affected by fatigue. It seems then probable that the waste products of metabolism like those drugs, tend to abolish functional continuity between neurons. And here again we find support for this view in the analogy of nerve and muscle; for it has been experimentally shown

that in excised tissues the junction between nerve and muscle is more readily affected by fatigue than either nerve or muscle.

This hypothesis finds further support in observations on the action of nicotine on the ganglia of the sympathetic nervous system. For it has been shown by Dr. J. N. Langley to be highly probable that nicotine abolishes the functional continuity between neuron and neuron in these ganglia, without markedly affecting the neurons themselves.

The action of these drugs then further tends to prove the correlation between consciousness and the passage of nervous impulses along new paths, *i.e.*, the establishment of new nervous connexions, for the possibility of the occurrence of both is diminished by them in an exactly parallel manner.

This argument remains good, though the fixity of continuity of nerve paths be not a function of the junctions of neurons, but depend upon some state of the cell bodies or their processes. Nervous impulses that are concerned in conscious processes pass through new or relatively new nervous paths, and in so doing improve their conductivity; and this process, the passage of the impulse along a new path improving its conductivity, is the immediate correlate of consciousness; and as by drugs and fatigue the process, be it called canalisation, organisation, "*Bahnung*," or the establishment of new functional connexions between neurons, is rendered impossible through increased resistance of the paths, so the possibility of the occurrence of consciousness is abolished.

PART III.

ON THE RELATION OF CONSCIOUSNESS TO OTHER EXISTENTS.

In the preceding section I have but brought together data generally accepted by both psychologists and neurologists and have explicitly stated the logical inference from them that is more or less vaguely recognised by several writers. It is perhaps allowable to attempt now, in the light of this conclusion, to define more accurately the relation of consciousness to other existents and form a working hypothesis as to the part played by it in mental process.

The ground must first be cleared by a protest against a certain form of materialism that finds expression not only in such writings as those of Dr. C. Mercier, but also in those of some of the psychologists and philosophers who protest most loudly against materialism.

Our earliest and most frequently repeated sense impressions are derived from solid objects, by touch, and the sense of weight and resistance when we exert ourselves to move them; by sight through the light reflected from them; and the affections of our temperature sense are also generally referred to the presence of solid objects. Hence the natural man is inevitably a materialist in the sense that to him matter is the most real thing.

The first result of philosophic thought seems to have been the division of the universe into matter and spirit. Man's soul or spirit was regarded as in every way the antithesis of matter, and it was usual to applaud the one and heap opprobrious epithets upon the other. The former process was a useful step, the latter was a quite unnecessary diversion. When the mediate nature of our knowledge of matter became more fully recognised, matter was regarded as less offensive because less real. Then came a time when men busied themselves with a third conception—that of energy, and matter might have been relegated then to its proper place, but that physicists had come to look on matter in motion as the type of all energy. They committed themselves to the statement that action at a distance is impossible, a dictum that now seems so absurd, and began the attempt to formulate mechanical hypotheses for the description of all manifestations of energy. This attempt was attended with so considerable success in the case of certain forms of energy, notably light and heat, that it began to be believed that the hypotheses represented truths and that all forms of energy would ultimately be shown to be but forms of the motion of matter. This attitude of the physicists lent an immense stimulus to the natural materialism of all men, the metaphysicians and psychologists not excepted, with the result that the division between materialists and spiritualists became more acute than ever before.

It is by those who have least freed themselves from our primitive materialism and who have accepted most blindly the mechanical hypotheses of physicists, that the vastness and mysterious nature of the chasm, as they call it, between consciousness and the motion of molecules is most loudly insisted upon. We have already seen how the doctrine of the simple concomitance of consciousness has been set up from such reasonings. And the influence of this materialism is manifested very widely by psychologists of very different types. I have noticed already Tyndall's dictum that 'we have no organ that can bridge the gap'. Wundt writes: 'We can conceive how one motion may be transformed into

another, perhaps also how one sensation or feeling is transformed into a second. But no system of cosmic mechanics can make plain to us how a motion can pass over into a sensation or feeling.¹ This sentence illustrates very fully the sort of assumption that I protest against, the assumption, namely, that we understand how one motion may be transformed into another in some fuller sense than that we have frequently observed this kind of sequence. A similar assumption seems to underlie the following sentence from an article by Bradley :² 'Between a process in the brain and a consciousness of energy there is really a gulf which is not to be filled up. You may know from experience that they are bound together, but, given the first, you could never have got to the second, and they remain in the end quite heterogeneous.' For it is implied here that in the case of other processes bound together you may know without experience that they are so bound together and may foretell the one on the occurrence of the other without previous experience of their relation. Similar statements are made by very many writers, and it is needless to multiply instances. What I wish to insist upon is that there is a certain crudity about all this. In insisting on the vastness of the gulf between consciousness and every other thing, writers seem to forget that the gap between all forms of manifestation of energy is really impassable by our minds ; that when we profess to understand something of them, of their relations to one another, of their mutual inter-convertibility, all that we mean is that we have observed the conversions, so that we are familiar with them, we have measured with more or less accuracy the equivalent quantities of the different forms, and in some cases we have formulated mechanical hypotheses concerning them. Having so defined and described certain features and relations, we are apt to forget that our knowledge of and about these things is purely inferential, that our pictures of them and their interactions are but convenient mental symbols, that their nature is utterly mysterious, and that the chasm between every two kinds of energy is completely impassable by our minds. As Lotze writes :³ 'Wir können leicht zeigen—dass in der Wechselwirkung zwischen Leib und Seele kein grösseres Räthsel liegt, als in irgend einem anderen Beispiele der Causalität, dass endlich nur eine falsche Einbildung bei diesen mehr zu wissen, die Verwunderung darüber erzeugt hat, dass wir hier nichts wissen'. And again Lotze writes,⁴ 'alle Wechsel-wirkung zwischen glei-

¹ *Human and Animal Psychology*, p. 6.

² *MIND*, xi., p. 321.

³ *Medicinische Psychologie*, p. 71.

⁴ *Ibid.*

chartigen Gliedern stattfindet,' since, as he puts it, soul and matter are alike the shadows of the realities underlying them and between which the interaction takes place. But Lotze wrote under the influence of a flourishing materialism, and from the modern standpoint we must modify this dictum and say that consciousness and all manifestations of energy are alike but shadows of the realities underlying them, that hence 'alle Wechsel-wirkung zwischen gleichartigen Gliedern stattfindet'. For we can no longer divide the universe into soul and matter. We now realise that it is not and probably never will be possible to describe all forms of energy in terms of the motion of matter, and that in dealing even with light and heat the mechanical hypotheses have not been completely successful.

Further it is now recognised that the forms of energy that affect our sense organs are but a small selection, as it were, of those of whose existence we have indirect evidence, while, as Prof. Ostwald¹ writes, 'Matter is nothing but a group of various forms of energy co-ordinated in space, and all that we try to say of matter is really said of these energies'; and as Prof. Mach² has insisted, when we treat of matter mechanically we are regarding it from only one of many possible aspects.

In considering the relation of consciousness to neural process it is our business as psychologists to treat of consciousness objectively, or as Shadworth Hodgson³ says, as 'an existent' in 'its dependent aspect of genesis and determination by nerve process' as distinct from 'its other aspect or character of a Knowing,' which must be left to be dealt with by metaphysicians. For 'It is this existent aspect of consciousness that is the object of psychology'. 'Psychology, therefore, has not to account for there being such a nature as consciousness, for this is the primary datum of all particular knowledge whatever, but, taking this nature as already known, to account for the genesis and subsequent history of it in individual living beings. And in order to do this, it is obvious that psychology must also treat the nervous system and process as realities or real existents, no less than consciousness.'

We have seen in the preceding part of this essay that consciousness seems to occur constantly in conjunction with the process of establishment of new nerve paths, of new functional connexions between neurons. If we reject the doctrine of the simple concomitance of consciousness, and regard it as playing some part, as performing some function

¹ *Science Progress*, Feb., 1896, p. 482.

² *Science of Mechanics*.

³ *Brain*, vol. xiv., p. 8.

in mental life, as we have seen imperative reasons for doing, we must suspect some causal relation between these existents, we must believe that consciousness is one of the conditions of the establishment of the new connexions.

In all probability, this establishment of connexions among neurons, connexions which seem to be the physiological basis of retentiveness, consists in a redetermination of the grouping of atoms and molecules, so that they shall swing in new positions of equilibrium; the immanent energy of these systems then determines the course of transformation of the transitive energy of mental activity, just as the immanent energy of stable equilibrium of the molecules of a seed must be supposed to determine in part the course of the transitive energies of the growing plant that springs from it. But however this may be, if we ascribe to consciousness a causal relation with, if we attribute to it a part in, the determination of nervous connexions, then we must admit that in its aspect of an existent, the consciousness of another man has to each of us a relation similar to that of those forms of energy, such as magnetism, the ultra-violet rays of the solar spectrum, the Röntgen rays, and many others, which do not directly affect our sense organs but are only known to us indirectly by their interaction with those forms of energy that do directly affect us. The only difference seems to be that our means of appreciating its occurrence and estimating its intensity are still more indirect, more uncertain and more inexact.

And unless we assume that the mind either destroys or creates energy, we must believe that consciousness is subject to the law of the transformation and conservation of energy, we must in fact believe that it is a form of energy, and that it has its heat equivalent that may some day be determined with more or less accuracy. Have we not an indication of this in the fact that neural activity seems to produce fatigue rapidly in proportion to the intensity of the consciousness that accompanies it?

The legitimacy of this way of regarding this aspect of consciousness may be illustrated by putting a hypothetical case. There are good observers who believe that telepathy is a fact, i.e., that the consciousness furnished by the brain of one individual, A, may, and sometimes does, affect the consciousness of another individual, B, without the intervention of the bodily organs of A. There is no ground for denying the possibility of this occurrence, and the only ground for believing it to be improbable is that it has not yet been satisfactorily proved to occur. Let us suppose, then, that some-

time in the future it should be proved to occur, and let us further imagine that the power of appreciating the consciousness of others in this way had become highly developed. Then if our appreciation were by means of some special sense organ, the relations of the consciousness of one individual to another would be strictly comparable, not merely, as at present, to the relation to us of the forms of energy indirectly appreciated, but to that of those forms that directly affect us.

While then psychology leaves consciousness in its aspect of a Knowing to metaphysic, it may assume as a useful working hypothesis that in its aspect of an Existent it is one of the forms of the manifestation of energy, that just as matter is but 'a group of various forms of energy co-ordinated in space,' so mind is a still more complex group of various forms of energy of which consciousness is one. We shall then regard mental activity, not as a mixed chain of neural and psychical events, but as a flowing network of cause and effect, consciousness forming a part of the strands, a part that is of very different importance in different kinds of mental activity. By adopting this hypothesis and thus bringing the relation of consciousness to other existents into line with the relations among the latter, we in no way diminish the mystery of the relation, we do but fill in a little more of the detail of the whole mystery of causality, as by all other advances in our point of view and knowledge of relations.

If we reject the simple concomitance view of consciousness and yet accept for mental process the principle of determinism, as is done by most psychologists, I cannot see that any other view of the function of consciousness than that here advocated can be held without involving irresolvable contradictions.

It would be idle to speculate further as to the exact part played by consciousness in establishing connexions among neurons, for we do not yet know in what those connexions consist, whether in some increase of the conductivity of nerve fibrils, the bringing of separate fibrils into continuity by the outputting of amœboid processes or otherwise, the modification of the substance intervening between neighbouring fibrils, perhaps by an orientation of polar molecules, or in some other physiological change.

The deductions from this hypothesis may be summed up shortly by saying that consciousness is the force that makes mind, that makes of neural processes experiences, that consolidates new reactions and thoughts into habitual mental processes, and habits into instincts and reflex actions. We act so or so, not because we are conscious now, but because we have been conscious in the past.