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ON THE NEURAL PROCESSES UNDERLYING ATTENTION AND VOLITION.¹

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IN the address which in accordance with custom it will be my duty to submit to you to-night I purpose saying something concerning the neural processes underlying two endowments which are to be found at the root of all our mental and bodily activities. They are endowments naturally obscure and difficult to understand, concerning which great differences of opinion exist both among psychologists and neurologists. I allude to the processes of Attention and Volition. It is still not uncommon for them to be regarded as separate and mysterious 'faculties,' in the old sense, and to find those who hold such views seeking, in the same spirit, to enthrone them in some definite centres in the cerebral cortex. It is the process of attention more especially that has given rise to an enormous amount of discussion during the last quarter-of-a-century. Previous to this period no very great diversity of opinion existed in regard to this mental endowment, or as to the complicity of the processes with which it is associated; but the promulgation of the doctrines of Wundt and Bain in regard to 'feelings of effort' as concomitants of the activity of motor centres or of the outgoing current, followed as it was soon afterwards by the

¹ Being a Presidential Address to the Neurological Society of London.

postulation and supposed location of true 'motor centres' in the cerebral cortex, speedily led to the enunciation of many new views concerning attention, perception, volition and other psychical processes. The brilliancy and importance of the experiments which led to the discovery of the centres in question, combined with the popular view of their interpretation, undoubtedly tended to foster the spread of the parent doctrines.

Now, however, when the fundamental doctrines of Wundt and Bain in regard to the nature and origin of the feelings of effort are believed by many to be absolutely disproved;¹ and when the derivative notion that 'motor centres' exist in the cerebral cortex has also, in the opinion of many, been shown to be almost similarly improbable, it seems an opportune moment to look beyond, and enquire as to the validity of the foundations for some of the new doctrines concerning attention and volition, which are also to be regarded as, in great part, derivatives of the fundamental notions above referred to.

It is clear that the two processes of attention and volition have so much in common that there must be a certain community of interpretation both from the psychological and from the neurological point of view. It is not likely, that is, that one process could be explained correctly from the old and the other from the newer point of view. If these newer views are untenable in the one case, they will be similarly unfit for the explanation of the related psychical process.

Let us first then, as a point of departure, look briefly at the old notions concerning the nature of attention and volition, so far as these were defined by British philosophers up to about the year 1840.

Both Reid and Dugald Stewart speak of attention as though it were an almost purely 'active' process, but James Mill, in his "Analysis of the Phenomena of the Human Mind," regards it rather as a two-sided process, as being both active and passive. Thus, he says,² "the other process

¹ Of Wundt only as regards his supposed 'feelings of innervation'; as he admits that one part of the feeling of effort is of afferent origin.—"Psychologie Physiologique." 1886, t. I., pp. 421 & 445.

² 1829, Vol. II., p. 290.

through which the mind is supposed to influence its trains, is Attention. We seem to have the power of attending or not attending to any object ; by which is meant that we can will to attend to it, or not to attend.' But on the following page he says—"The state of mind under a pleasurable or painful sensation is such, that we say, the sensation engrosses the mind The phrase engrossing the mind is sometimes exchanged for the word attention. A pleasurable or painful sensation is said to fix the attention of the mind. But if any man tries to satisfy himself what it is to have a painful sensation, and what it is to attend to it, he will find little means of distinguishing them. Having a pleasurable or painful sensation, and attending to it, seem not to be two things, but one and the same thing The feeling is not one thing, the attention another ; the feeling and the attention are one and the same thing." Similarly, in regard to other modes of attention, Mill held that, "as in the case of sensation, attending to an interesting idea is merely having it ; attention to an indifferent idea is merely associating it with some idea that is interesting." These extracts suffice to show that for James Mill the process of attention was an essentially passive one, and that its apparently active element was only due to the superaddition of Will or Volition.

The view of Sir William Hamilton concerning attention was very similar. That attention is in its essence more of a passive than of an active process is evidently Hamilton's view, since he says:¹—"I think Reid and Stewart incorrect in asserting that attention is only a voluntary act, meaning by the expression voluntary an act of free-will It therefore, appears to me the more correct doctrine to hold that there is no consciousness without attention,—without concentration, but that attention is of three degrees or kinds. The first, a mere vital and irresistible act ; the second, an act determined by desire, which, though involuntary, may be resisted by our will ; the third, an act determined by a deliberate volition. An act of attention—that is an act of concentration—seems thus necessary to every exertion of consciousness." And previously (p. 237) he had written :—"Attention is conscious-

¹ "Lectures on Metaphysics," (Delivd. 1836-37) Vol. I., p. 247.

ness and something more. It is consciousness voluntarily applied, under its law of limitations, to some determinate object ; it is consciousness concentrated."

The views commonly held in regard to Volition up to the early part of this century were not appreciably different from those put forward by Locke at a much earlier period, who, in the simple language of his time said :—" We find in ourselves a Power to begin or to forbear, continue or end the several Actions of our Minds and Motions of our Bodies, barely by a thought or preference of the Mind." No details, however, were offered by him as to the mode in which 'will' was capable of influencing either the actions of our minds or the motions of our bodies. For the first valuable hint as to the details of the latter process we have, indeed, to turn to James Mill, though Hartley had made an attempt in this direction when he said :²—" Of the two sorts of motion, viz., Automatic and Voluntary, the first depends upon Sensation, the last upon Ideas." James Mill's contribution to our knowledge of the subject was, however, much more important. As others had done, he called attention to the fact that a feeling of an emotional order, known as 'desire,' was a necessary prelude to a voluntary movement, but that something else accompanies or immediately follows this emotion of desire—viz., an Idea or Conception of the kind of movement needed for its gratification. He says,³ " We do not undertake to say what physical links are between the Idea and the Contraction, any more than between the Sensation and the Contraction. *The Idea is the last part of the Mental operation.*" This idea of the movement to be executed was declared by Mill to be two-fold in its origin. In reference to this he said :—" There are two ideas very different from one another, to both of which we give the name 'idea of the action.' . . . One is the outward appearance of the action, and is always a very obvious idea." The other is a copy of certain internal sensations. which a few pages previously he had spoken of

¹ " Essay concerning Human Understanding," 1639, Bk. II., Chap. 21, § 5.

² " Observations on Man," 1748, Chap. I., § 8.

³ *Loc. cit.*, Vol. II., p. 266.

generally as "sensations accompanying the movement," and which he also more specifically defined (*loc. cit.*, p. 275) when speaking of the terminal events of a movement as "the contraction of the muscles, with the various sensations which the action upon these organs, and the actions excited in them imply." Of these internal sensations, he says, "from the habit of not attending to them, we have lost the power of attending." And then he adds, "this last (namely the revival of such internal sensations) is by no means an obvious idea. And the mind passes from it so quickly, intent upon the action which is its result, that it is almost always swallowed up in the mass of association. It constitutes, in fact, one of the most remarkable instances of that class of links in a chain, which, how important soever to the existence of the chain, are passed over so rapidly, that the existence of them is hardly ever recognized. . . . This last Idea alone is that upon which the contraction is consequent."

After this brief introduction we will now turn to some of the more modern conceptions as to the nature of attention and volition.

ON THE RELATIONS EXISTING BETWEEN ATTENTION AND VOLITION.

Both attention and volition are in part feelings of a so-called 'active' type; the exercise of each of them being associated with a 'feeling of effort.' Attention is the more primordial endowment; and volition is in part a development therefrom, in which, however, the root process is easily to be detected.

Attention may be directed to impressions made by things without—that is to sensations; or to their revival in idea—the latter mode of activity being known as 'reflection.'

Attention itself is commonly held to mean a "concentration of consciousness." The more our consciousness is narrowed and focussed, as it were, upon some one object or thought, the more developed is that state of mind known as attention. On the other hand, the wider the area of consciousness, at any given moment, (the larger the number of

objects or ideas simultaneously present), the less vivid is our state of consciousness, the less developed is that phase of mind known as attention. This mode of activity is, however, named 'apperception' by Wundt.¹ The entry of an object into the field of vision he speaks of as perception; but when it becomes the object looked at—the central point—there is what he calls apperception, or, as others would say, a process of attention.² With this process, there is always a particular feeling of effort associated. He agrees, in fact, with Fechner in saying that there is always a feeling of tension in the sensorial organs corresponding with an act of external attention, while with an act of internal attention (reflection) there is a similar feeling referred to the scalp, especially in the occipital region.³

But attention varies in its degree of complexity; it is simple or 'spontaneous,' for instance, when we are exposed to some very vivid or novel sensorial impression, or when there is the memorial recall of some extremely painful or pleasurable incident. Attention is usually rendered, under such circumstances, as it were automatically and without effort—and, as Ribot insists, in response to some emotional state.⁴ On the other hand, attention may be initiated in a more complex manner, as in those cases where it seems to be indissolubly associated with an act of will or volition. This is the higher phasis known as 'voluntary attention'; it is the process by which we compel ourselves to observe certain external phenomena, not of absorbing interest in themselves, but for some ulterior purpose; or in which we direct our thoughts upon a given subject with a view to develop our knowledge of its relations.

Voluntary attention appears to be a compound or fusion of the two states, volition and attention. This seems all the more clear when we remember the two spheres of will

¹ According to Prof. Cattell (*Mind*, vol. xlii., p. 488) the word 'apperception' was introduced into philosophy by Leibnitz to denote a spontaneous activity of the mind through which presentations are clearly distinguished. The word was also made use of by Kant and by Herbart, previously to the time when Wundt assigned such a prominent place to it in his psychology.

² *Psychologie physiologique*, 1886, t. II., p. 331.

³ See also Ribot, "The Psychology of Attention," Chicago, 1890, pp. 22, 67-69.

⁴ *Loc. cit.*, pp. 12, 16, and 32.

long ago indicated by Locke. The direction of our thoughts is, in fact, as much a mode of volitional activity as is the production or the control of movements in predetermined modes. Nay, more, it happens that the psychical process preceding the production of all voluntary actions whatsoever differs little, if at all, in its essential characters from that which is comprised in an act of voluntary attention (Wundt). Anteriorly, however, there is in volition another important process; there is more or less of a weighing of motives prompting to this or that kind of action—that is, of deliberation. This deliberation terminates in the dominance of one or other of the motives under consideration, and with this there is generally associated the idea of some action to be performed now or at some future date. This dominance, therefore, makes more vivid the idea of its particular associated movement or series of movements. Coincidentally, if there is to be present action, there is the removal of all ‘inhibition,’ and the ideal movement becomes immediately replaced by the actual movement which it prefigured. As to this latter process Hume said :¹—“ But the means by which this is effected; the energy by which the Will performs so extraordinary an operation; of this we are so far from being immediately conscious, that it must ever escape our diligent enquiry.” To this prognostication we may, I think, fairly demur. Our knowledge of the functions of the Rolandic area, and of its relations through the pyramidal system of fibres with motor centres in the bulb and in the cord, does, in part, redeem us from this reproach of hopeless ignorance.

ATTENTION.

In reference to Attention three problems seem especially worthy of consideration :—[1] as to the essential nature or mode of production of the process of attention; [2] as to the exact relation of attention to motor activity, and as to its intensification or diminution thereby; [3] as to the cerebral seat or mechanisms concerned with this endowment.

¹ “ A Treatise of Human Nature,” 1787.

Under one or other of these heads most of the principal difficulties or differences of opinion in regard to attention may be discussed.

1. *As to the Essential Nature of Attention.*

How is it that the limitation in the area, or concentration of consciousness, in which attention seems to consist, is brought about? This is a very difficult problem if the enquiry is confined to the essential neural process itself. In seeking for light on this subject we should, therefore, face it in its simplest form. What happens, for instance, in a case of spontaneous attention to some novel visual impression, when, with all other avenues of sense open, we seem to be aware only of this particular visual impression—all other modes of consciousness seeming to be for the time blotted out? I am not prepared with any new answer to this fundamental question, nor have I been able to find any definite reply thereto in the writings of other neurologists or psychologists.

Some such attempt, it is true, has been made by Maudsley. Speaking of the conditions of consciousness generally, he says:¹—"The persistence for a time of a certain degree of intensity of energy in the ideational circuit would certainly appear to be the condition of consciousness;" and two pages further on he adds, "*Attention* is the arrest of the transformation of energy for a moment—the maintenance of a particular *tension*." This, however inadequate, does afford some sort of an explanation. It gives some account (a) of the reason why a particular impression should in certain cases become dominant, and also (b) why other impressions should, for the time, be blotted out of consciousness.

As to the first point, we know (a) that the adequacy of a given impression to become dominant and all-engrossing depends greatly upon the individual's experiences and tastes, and thus is dependent even more upon the previous activities of other brain elements than upon those now being primarily excited from without. For instance, the effects produced by setting light to a long train of gunpowder would concen-

¹ "The Physiology of Mind," 1876, p. 806.

trate the attention of a savage who had never previously seen such a marvel, very much more than it would concentrate the consciousness of one of ourselves. In the cortical cells excited in us by the impressions derived from the explosion of a train of gunpowder, the molecular activities aroused would, in part, at once well out through a series of commissural fibres to other sensory centres, there to revive related past impressions, so that we should immediately perceive or realize the nature of the external cause. But in the savage, the experience being a novel one, the molecular activity aroused could not at once flow out through such commissural channels; these would not exist; there might consequently be momentary tension in the cells of the visual centres; and (b) the superior intensity of this process might therefore, by comparison, dim or blot out other coexisting but weaker and more familiar impressions—just as, to take a rough example, in coming from bright sunlight into a darkened room we are at first unable to discern anything. Similarly, a pain or a pleasure, but especially the former, may concentrate our consciousness so as to exclude all else, by its mere intensity.

In either of these cases, the novelty, the intensity, the pain, or the pleasure associated with the external impressions, cause them to engross our attention. It is given by no effort of our own; it is, as it were, commanded and no resistance is offered.¹

In the majority of cases, however, where attention comes into play, it does so by virtue of some selective and controlling process, which we ourselves initiate. It is started from within, that is, rather than from without. Such processes

¹ Cycles ("The Progress of Human Intelligence," 1880, p. 188) says: "In cases where Impression chiefly is acting (that is where reminiscence, ratiocination, &c., are not playing much of a part), our attention is quite at the mercy of vividness or intensity * * * In looking at a scene in a merely general way, anything moving attracts us—the flight of a bird, the flashing fall of a cascade, the waving trees, will draw our regard from the still objects; but if among these latter there be one showing colour, it might successfully compete with the things in motion. A shrill cry from another part of the scene might cause us to turn the head wholly away. But if, when gazing at one thing moving, another in the line of vision moved quicker, or if beside one patch of colour another were to show of a fierier hue, shift the eye we must—that is, if we had not some motive to the contrary stirring a volition." This same author makes a very elaborate but obscure attempt to explain the process of Attention from a Neurological standpoint. Still his explanation contains some valuable suggestions (*loc. cit.*, pp. 122-161).

are of various degrees of complexity. But, as Ribot says:¹—"In voluntary attention the aim is no longer set by hazard or circumstance; it is willed, chosen, accepted, or at least submitted to; it is mainly a question of adapting ourselves to it, and of finding the proper means for maintaining the state; hence voluntary attention is always accompanied by a certain feeling of effort The birth of voluntary attention, the power of fastening the mind upon non-attractive objects, can only be accomplished by force, under the influence of education It is an instrument that has been perfected—a product of civilization Love of work is a sentiment of purely secondary formation, that goes hand in hand with civilization. And we may note, now, that work is the concrete, the most manifest form of attention. Continuous work is repugnant even to half-civilized tribes."

All processes of 'voluntary attention' are, however, complex phenomena which, as I venture to think, are compounded of volition and attention. Some of the means by which we turn our attention in this or that direction will be referred to in the next section; while others will be spoken of when we treat of volition itself—which seems to be the most distinctive side of this complex process known as 'voluntary attention.'

2.—*As to the Relation of Attention to Motor Activity, and its Intensification or Diminution thereby.*

It is the fashion with some at the present day to speak of attention as an essentially 'motor process.' This view, however, does not seem to me a just one although, for reasons to be stated, motor activity is inseparably bound up with almost all processes of attention.²

¹ *Loc. cit.*, pp. 85-48.

² Ribot, *loc. cit.*, pp. 8, 25, & 29. This author admits however, that there is no decisive proof as between his view, and that which holds that motor phenomena are simply inseparable elements in attention. Thus he says (*loc. cit.*, p. 60):—"But the reader will say: 'We admit that there are motor elements in perceptions, images, and, to a less degree, in concepts. Still, that does not establish the fact that attention acts upon them, and through them, and that it is a motory mechanism.' True, upon this point we can cite no observation or experiment that would be decisive. The crucial test would consist in discovering whether a man, deprived of all external and internal motility—and of that alone—would be still capable of attention. But that experiment is not practicable." Sully, however, says (BRAIN, 1890, p. 155):—"I think, if we

The cause of this inseparable relationship is, in the first place, the fundamental one, that throughout the animal world expression invariably follows impression ; or, in other words, that by the very constitution of our nervous systems impressions made from without upon nervous ganglion cells, and the molecular motions there liberated, flow towards other groups of ganglion cells, and thence outwards through nervous channels, either diffusely or along definite routes. In this way either generalized or more or less obviously special movements in response are evoked.

In our waking state, when all our senses are to some extent active, a diffuse and almost imperceptible wave of molecular movement is ever welling out to the various muscles of our body, so as to maintain in them the condition known as 'tonus,' together with those persistent, more or less slight, activities needed to maintain the necessary equilibrium between opposing groups of muscles.¹ But, let our sensorial activity be cut off by the supervention of sleep, and immediately there is a diminished reverberation of external impressions through the nervous system ; and there is consequently a diminution of this diffusive outgoing wave, as is at once shown by the nodding head and relaxed limbs of the sleeper.

But, if the states of consciousness which, as a whole, enter into or compose our waking condition are attended by this subdued and generalized outflow of molecular activity making for the whole muscular system, there are also equally fundamental reasons why special excitations of sensorial activity should be associated with special muscular movements—and that, too, as initiatory or accompanying rather than as consecutive phenomena.

The conformation of the sense organs of animals as well as their relation to the external stimuli by which they are

carefully examine our states of mind when we are attending to impressions or ideas, we are in some cases able to distinguish attention as something apart from and independent of muscular activity. Thus, as everybody knows, we may fix the eye on an object and yet not attend to that object. Helmholtz notices the fact that we can attend to an object in the side regions of the field of vision without fixating the object. Where, one may ask, is the motor factor, the process of muscular adjustment in this case ?

¹ See Ribot (*loc. cit.*) p. 26 (2).

excited makes this a necessity. Sounds may come to the ears from all sides; so that movements of the body, of the head and neck, or of the ears themselves are needed for their perfect or better appreciation. The same holds good for visual impressions and visual organs; and how much the sense of touch is heightened by movement is familiar to all. Taste is also intensified by certain movements, and, though to a still smaller extent, the sense of smell. Throughout the whole animal series, and as long as animals have existed, there must always have been this inseparable relation between the several modes of sensorial activity and movements. Such movements are, as we have seen, either more or less permissive of the sensorial activity, as when the head is turned in a particular direction; or they go to develop or intensify the impressions that can be received, as when movements of the eyes, ears, or hands take place with the effect of vastly augmenting the range or the intensity of the respective visual, auditory, or tactile impressions.¹

What wonder then that in association, for instance, with visual or auditory impressions there should have grown up an inseparable motor response of a more special kind, to wit, a turning of the head and eyes in the direction of the sight or sound, together with a fixed attitude of the body generally.

That there should be an 'attitude of attention' is, as we see, perfectly natural; just as it is perfectly natural that with different emotions there should be different special

¹ 'Adjustment of attention' to its objects is commonly spoken of as though it were a motor process. Wundt does so, for instance, because of the existence of sensations of tension referred to the corresponding sense organs. In 'pre-attention' or 'expectant attention,' such sensations may, it is true, come from merely permissive muscular actions in the sense organs. But if reaction time is diminished when the nature of the impression is known beforehand, and still further when the time of its occurrence is also known; such adjustment is surely in great part sensory and dependent upon the fact that an image or idea of the event foreseen is evoked, and evoked at exactly the right time, so that, as Ribot says (*loc. cit.* p. 74), "the real event is but the re-inforcement of the representation already existing." The supposition made by Bain and others that mere ideal recal of perceptions involves a feeling of tension in the corresponding sense organ is very questionably true. Such feelings of tension or effort (in accordance with the view that they are of afferent origin) would require distinct contractions of muscles for their generation. But obvious contractions of muscles are mostly absent in such cases. And no one has peripherally initiated feelings of effort from mere "nascent" excitations of muscles, stopping short of producing actual contractions.

motor accompaniments. But because of these inseparable motor accompaniments, it seems to me we might almost as reasonably say that emotion is an essentially motor process as make such an affirmation concerning attention.

Each of these mental processes is, I believe, especially concerned, in different modes, with the activity of sensory elements, although a special welling over of molecular activity into related motor mechanisms is also almost inseparable from the activity of each of them. In other words, we have to do both in emotion and in attention with sensori-motor processes, though, in my opinion, the ganglionic elements concerned with the motor side of this activity lie altogether outside the cerebral hemispheres, just as the activity of such motor mechanisms lies altogether outside the sphere of consciousness.¹

The question of the direction of attention, or the degree to which it may be intensified or diminished is one which really pertains to the subject of volition, as it only comes

¹ Thus, to say, as Prof. James does ("Princip. of Psychol.," 1890, vol. i., p. 80):—"Ideas of sensation, ideas of motion are, on the other hand, the elementary factors out of which the mind is built up," is quite in accordance with my own beliefs. We have in the cerebral cortex an extended register of two kinds of sensory impressions—those which primarily *incite* to movement together with other sensory impressions (kinæsthetic) resulting from such movements and constituting the subsequent *guides* for the execution of similar movements. Just as the different kinds of sensory centres belonging to the first set are brought into intimate relation with one another by means of commissural fibres, so are the kinæsthetic centres similarly connected with each of the other sensory registers. The statement quoted above is, however, quite a different thing from saying as Hughlings Jackson ("Clin. and Phys. Researches on the Nervous System," 1876, pp. xx-xxvii.) has done with much insistence that "mental operations in the last analysis must be merely the subjective side of sensory and motor substrata"; or from saying as Ribot ("Les mouv. et leur import. psychol." in *Revue philosophique*, Dec., 1879) does that we have such things as "motor ideas," that "movement and sensation are the stuff of which our mental life is composed," or that "at the root of our mental life, everywhere and always there are movements." I should agree to the last proposition if "ideas of movement" were substituted for "movements." All the other modes of expression imply that there are motor centres in the cortex, and that the activity of motor centres carries with it a subjective phasis, both of which positions I, in common with James, Münsterberg and others, believe to be erroneous. The "idea of the movement," apart from its visual component, is an image of a body of ingoing impressions caused by the movement itself, and the registering centre for these impressions has precisely the same claim as the visual and the auditory to be regarded as a sensory centre. This is the view also now held by Ribot, though formerly, as we have seen, he used language seeming to imply that ideas of movement are revived in motor centres ("Psychol. of Attention," p. 54). His real view is explicitly stated, however, on pp. 26, 27, 66 and 67.

into play when 'voluntary attention' is being exercised. This subject will, therefore, be referred to when I speak of the mode by which our thoughts are controlled or concentrated in this or that direction.

3. *As to the Cerebral Seat or Nervous Mechanisms concerned with Attention.*

In his recent very interesting paper, read before this Society, on "The Psychophysical Process in Attention," Sully says: "In England as well as in Germany the question of the precise region of the cortex involved in the process of attention has been the subject of considerable discussion."¹ It is well known, also, that Ferrier localises the "faculty of attention" in the frontal lobes. His most recent statement on the subject is this. Speaking of the effects caused by removal of the frontal lobes, he says:² "I have also observed (and my observations have been confirmed by Hitzig and Goltz) a noteworthy psychical defect—a defect which I have endeavoured to correlate with the inability to look at, or direct the gaze towards, objects which do not spontaneously fall within the field of vision. It is a form of mental degradation which appears to me to depend on the loss of the faculty of attention, and my hypothesis is that the power of attention is intimately related to the volitional movements of the head and eyes." This latter view Ferrier

¹ BRAIN, 1890, p. 147. Sully, in fact, seems to suppose that we have to look in the main for some "higher motor centre" as being specially concerned with the process of attention. He says elsewhere ("Outlines of Psychology," p. 77): "The fact that attention is an act of the mind would suggest that its nervous concomitants are certain processes in those nerve centres which we know to be more especially concerned with movement and action. This conjecture is borne out by the fact that the act of attention is commonly accompanied by muscular contractions"—referring here to the movements of the head and eyes and the attitude of the body generally during acts of attention. Again, further on, he says (*loc. cit.* p. 681): "In the control of movement and of feeling, nervous influence appears to pass from the higher motor centres (including those of attention) to the lower motor centres from which this process of innervation concerned in the impulsive or emotional movement sets out." Still Sully has since contended (BRAIN, 1890, p. 157) that attention "cannot wholly be resolved into a motor phenomenon." He adds: "The relation of the two is, I suspect, very similar to that which obtains between an emotion and the several sensory and motor phenomena which accompany it." This latter conclusion may be admitted as correct; but the holding of such a view is surely not in accordance with the language previously quoted.

² "Cerebral Localisation," 1890, p. 151.

puts elsewhere in the following words:¹—"The faculty of attention with all that it implies in the sphere of intellectual operations, must be intimately related to the volitional control of the head and eyes in association with the centres of visual perception and ideation."

No attempts at the localisation of attention are made by Bain. He, in fact, gives no details concerning attention, or as to the way in which it is brought about.

Wundt, however, does postulate a distinct organ for apperception (attention) which he also is inclined to localise in the convolutions of the frontal lobe.² But it should be said that his theories concerning apperception, its localisation, and the modes of cerebral activity with which it is associated are entirely speculative and fanciful.³ He postulates the existence of this centre of apperception, to which, as he imagines, all sensory impressions are sent in duplicate (by way of the cerebellum), and from which again he postulates the issue of one set of fibres to each of the cortical sensory centres, together with another set to each of the supposed motor centres of the cortex. What happens when attention is aroused by some external object is, according to Wundt, as follows:⁴—"The first effect is the production of an image of an intuitive or imaginary order, not sharply defined, but as it would be if much to the side of a visual field. This, Wundt regards as the result of the stimulus upon the cortical visual centres, but he adds: "The sensorial irritation is at the same time transmitted to the central territory of apperception. Thence the stimulus follows a double route and directs itself (1) backwards towards the sensory territory with the effect of reinforcing the image; and (2) towards the motor centres which innervate the voluntary muscles, as a result of which there are necessarily produced those muscular tensions that assist to constitute the feelings of effort accompanying attention, and which react in their turn upon attention—reinforcing it in conformity with the

¹ "Functions of the Brain," 2nd Ed., 1886, p. 264.

² *Loc. cit.* t. I., p. 245, and fig. 65.

³ See art. by Bain in *Mind*, 1887, pp. 174-8.

⁴ *Loc. cit.* t. II., p. 236.

law that associated feelings lend one another a mutual support."

With most of these statements and points of view I have myself no sympathy. As will have been seen, I take a totally different view as to the relations of the centres concerned with the turning of the head and eyes to the process of attention from that adopted by Ferrier, nor can I regard attention, whether called by its own name or by that of 'apperception,' as a 'faculty' which, somewhat in the old phrenological sense, is to be definitely localised in this or that portion of the cortex; and least of all could I think, if it is to be topographically localised, that we should place this essentially sensorial endowment in that region of the brain which may, truly enough, be concerned with the production of one of its commonest motor accompaniments or reactions. The reason why there must necessarily be such motor reactions and accompaniments is, as I have said, dependent in part upon the constitution of our nervous systems, and in part upon the fact that we are compelled to react by turning the head and eyes in this or that direction, because from all sides visual and auditory stimuli may come to us. The relation between these particular movements of the head and eyes and attention do not, therefore, convince me that they are other than almost necessary results of sensorial activity. On the other hand, I should not think of attempting to localise the process known as attention in any one definite part of the brain, but should regard it as having its loci in cell and fibre mechanisms in each one of the cortical sensorial centres—that is, as being concerned with mechanisms scattered all over the cortex, according as we are, with more or less predominance, attentive to visual, auditory, tactile, olfactory, gustatory, or kinæsthetic impressions.

VOLITION.

As already intimated the sphere of what is called Volition is commonly believed to be two-fold. Thus, one form of such activity is supposed to exist which manifests itself in the control or guidance of our thoughts; and another in the pro-

duction of muscular movements. These two processes correspond with what Wundt terms the "internal and the external activity" of Will. What really happens in these two cases we must now consider.

In the first place it is necessary, here also, to get rid of the erroneous notion that under the head of Will or Volition there is to be included a distinct 'faculty' having a cerebral localisation of its own in some part of the cortex—an imaginary 'faculty' acting as a well-spring of power, isolated and mysterious in its origin. Still less can we believe that Will is "a species of spiritual rudder distinct from and superior to the automatic forces of the brain."¹

According to Bain the external and the internal modes of activity of will are essentially similar; he holds that in each case the fundamental action is through motor centres and muscles, and his view has been adopted by Ribot and others.²

Bain says:³—"I look upon volition as existing only in connection with the active organs, that is, with the muscular system. Even in the sphere of thought the limitation holds." For Wundt, James and others, also, any difference that might be thought to exist between the two processes is more apparent than real. They, however, differing from Bain, regard as fundamental the nervous processes that occur anterior to the actual incitation to the movement—holding, as they do, that the activity of muscle is a non-essential and mere physical addendum to the volition itself. As Wundt points out, in certain cases of paralysis the will to move may be there and made—even though the movement does not follow.⁴

¹ *The Spectator*, June 6th, 1891, p. 798.

² *Loc. cit.*, p. 51.

³ "The Senses and the Intellect," 3rd Ed., p. 559.

⁴ As to the psychological characteristics of the two modes of volitional activity (internal and external) Wundt (*loc. cit.* t. II., p. 445) contends that there is a feeling of internal activity or effort associated with each of them, but in cases of the latter type where movements follow, he says, "this feeling receives here a characteristic colouration because it becomes fused with the sensations of the movement itself, so as to constitute an inseparable complexus." The birth of this fusion becomes, therefore, for Wundt the fundamental basis by which 'external voluntary activity' is to be distinguished psychologically from 'internal voluntary activity.'

The Nature and Extent of Voluntary Power over the Control and Direction of our Thoughts.

That we have some power of controlling or directing the succession of our thoughts is generally recognised, and confirmed by the consciousness of each one of us. It seems obvious, also, that this aptitude may not only be improved by practice, but that it is naturally much better developed in some persons than in others—and especially in those whose powers of attention are strong.

In all such processes of direction or control of thought we have the manifestation of the highest phase of attention—that known as ‘voluntary attention’—the consideration of which was previously postponed till the present stage of our enquiry was reached; so that what is now to be said will bear as much upon the subject of voluntary attention as upon volition proper.¹

I must take it as commonly admitted that the succession of our thoughts depends upon what is known as the ‘association of ideas’; and that these associations are but reflexes of the sequences and coexistences obtaining among the various sensorial impressions to which we are and have been from moment to moment exposed throughout our whole lives. Thus the mind of man is, as Leibnitz called it, a ‘mirror of the world,’ so far as it is revealed to each one of us.

Again, it is well understood that for the purpose of influencing or altering trains of association, the power of direct impressions is more potent than that of mere remembered impressions. Consequently, when we are in the midst of a train of abstract thought, any vivid impression coming to us

¹ What is now to be said may constitute an answer, in fact, to those who still believe in the spiritual conception of Will. Thus a writer in *The Spectator* (June 6, 1891, p. 789) has recently said that “voluntary or scientific attention” is, “an act of pure will, meaning by will, of course, not that which is the resultant of pre-existent impulses and desires, but that self-caused effort by which scientific attention is distinguished from all such acts of involuntary attention We know nothing if we do not know that we ourselves cause for ourselves all such acts of attention, and that science of all kinds is the organised result of such acts As we said last week, ‘will’ is a word of supererogation, it is a will-o’-the-wisp which has no pretence for existing at all, if it represents nothing but a resultant of desires.” Yet that this latter view is true, we shall now endeavour to show.

from without will tend to arouse associations of its own, and thus disturb our previous trains of mere reminiscence.

If the subject on which we are thinking is associated with external observation, the one or two senses concerned are of course active and receptive, and the vivid impressions that we receive through them suffice to fix our attention and control our thinking processes. If we wish to divert our attention from either of these vivid sensations, so as to be enabled to follow some other line of thought we can avert our eyes, or close our ears, so as to cut off the disturbing impressions. In abstract thought we often naturally close our eyes, court silence, and keep perfectly still, so as to have no externally derived impressions of any kind disturbing our trains of association.

We are concerned in all such cases with mere reminiscence or memorial recall of past impressions, together with intellectual activities related thereto. During such a process portions of almost the whole of the cortex may be maintained in a condition of full or sub-conscious activity as, with "the rapidity of thought," molecular notions pass along countless definite lines or associating channels between this and that group of ganglion cells. The nervous activity tends in each case to pass most and with greatest ease along those channels which have hitherto been most frequently traversed—taking the routes, that is, which custom has rendered "lines of least resistance." As an able writer says: "In this way trains of thought of any length may be excited; until the original nervous activity either emerges by some form of expression into the outer world, or becomes absorbed in the stronger current of a fresh direct sensation."¹

Thus it is found that our thoughts invariably follow one another by the laws of habit or association (these being, as I have said, a reflex of external co-existences and sequences), the most vivid sensation or idea for the time being ever filling our consciousness and rousing, through associational channels, related ideas and concepts. So that the continuance for a time of any one of them merely proves that during the

¹ Barret, "Physical Ethics," 1869, p. 315.

period of such continuance there is no other strong enough to drive it out.

If, therefore, our thoughts succeed one another in this way according to definite laws, it may be asked (a) what is the province of volition or will in regard to their direction, and (b) by what means can any such influence be exerted?

(a) As to the first question I believe nothing more definite than what Barret expresses in the following passage can be said:¹ "We may, indeed, if we like, give to those sequences in which one train of thought *supersedes* another the name of 'will,' as distinguished from those which are regular members of one continued train; but their nature and foundation must be the same in the one case as in the other; for the second train must have some origin like the first, and can only conquer by its superior force." It comes, in fact, to this, that our thoughts invariably occur in accordance with the 'laws of association'; but that in some cases, changes in their order, or a persistence in the same order, is said to be a result of 'will.' It is well known that Wundt and others assert the need of something beyond the mere association of ideas as being required for a scientific understanding of the so-called 'active' powers of mind, and that it was with this end in view that he postulated the existence of his so-called faculty of apperception, carrying with it activities of its own apart from the ordinary laws of the 'association of ideas.' Münsterberg has of late conducted two most important and skilful experimental investigations bearing upon the question of the existence or not of any such need. After a careful analysis of these researches Croom Robertson sums up the impressions they have produced in the following manner:² "Taken together the two researches in their different way certainly point to one conclusion—that there is no such difference between so-called voluntary and involuntary intellection as Wundt's apperception theory (or any other like it) would make out."

(b) It remains then to consider how this superseding of one train by another, or continuance of an old train in spite

¹ *Loc. cit.*, p. 142.

² *Mind*, 1890, p. 242. F. H. Bradley also expresses strong opposition to Wundt's doctrine of apperception (see *Mind*, 1887, p. 366).

of a tendency to wander, is or can be brought about ; in order to indicate the kind of means by which what is called 'will' acts in directing or controlling the course of our thoughts. On this subject a few hints only can be given, concerning the different methods known to be adequate for the attainment of such ends.

(1) In the first place it should be stated that there is a sort of antagonism between the mental activity of mere reminiscence, and that which is set on foot or maintained by external impressions—for the reason that the same central elements are called into activity in the two cases. Consequently, when any very interesting train of thought is being carried out we may become for the time 'self-absorbed,' and, during this period, much less receptive of external impressions, so long as they are not very intense. Moreover, when so engaged we always try to guard ourselves from the possible disturbing influence of external impressions of all kinds.

(2) Of the two opposing processes that which is externally derived (impressional activity) is decidedly more vivid and potent than that which is internally initiated (reflective activity) ; and it is this fact that enables us at any time (α) to interrupt and supersede a train of thought proceeding in accordance with the laws of association ; or, on the other hand (β) to maintain it when we so desire.

In the one case, in order (α) to break in upon a train of association we may call into action some vivid sensorial impression, and we may repeat this operation till we have finally displaced the old train of thought—often simultaneously seeking the aid of bodily movements of one or other kind, which are potent in this direction by reason of the kinæsthetic impressions that ensue, and the new trains of association that may be initiated thereby.

While, in the other case, where (β) we seek to maintain some train of thought in spite of a tendency to wander to other subjects, we call in the aid of language. That is, we repeat to ourselves some words essentially related to the subject of our thoughts, or we may sum up the stage at which we have arrived in words, thereby reinforcing the existing

associational activity to which our attention is being given, through the mixed auditory and kinæsthetic impressions produced. How very influential this mode of control is may be gathered from the added power of this kind that we obtain when we call into play the aid of writing, and thus help to maintain desired trains of reminiscence by means of additional reinforcing sense impressions, of the visual and kinæsthetic order. Most of us must be familiar with the much greater ease with which we keep our thoughts along certain lines, and even develop them, when we are committing them to writing, as compared with what happens when we do not call into play this extra aid.

Thus, whether we seek to alter, or to maintain and develop, any particular line of thought, we call up as many new impressions as possible—of unlike kind when we wish to disturb or break in upon a previous line of reminiscence; but of like or of related kind where we desire to strengthen and develop the previous associations upon which we have been intent.

What has been said above might seem at first sight to lend support to the views expressed by Bain,¹ that “in all voluntary control of the thinking trains there is a muscular intervention” of a direct kind, so that, as he contends² “the retention of an idea in the mind is operated by voluntary muscles.” This, however, cannot be admitted. Will operates, as we have seen, through the muscles only in an indirect way—that is, the muscular actions to which we resort give rise to ingoing impressions, and it is these which, according to their nature, may break up or may reinforce pre-existing trains of association. That is, there is a superseding or a strengthening of previous lines of thought, but in either case the effect still occurs in strict accordance with the laws of association.

It is perfectly true, therefore, that the excitation of muscles (more especially those of our sense organs or those concerned with speech) is an essential preliminary to the guidance or control of our thought processes, though this guidance or control seems not to be brought about as Bain

¹ “Senses and Intellect,” 3rd Ed., p. 421.

² *Loc. cit.*, p. 370.

would have us believe, or in such a way as to justify the language which he employs.

It must be borne in mind, in fact, that this voluntary muscular activity itself occurs as a sequence of one of the links in the association of ideas; and that the resulting control or change in the direction of our thoughts is brought about by the sensory results of the movements thus induced—that is, by auditory or visual in concert with kinæsthetic impressions reaching the brain, and again, according to their nature, and by the ordinary laws of association, helping either to change or maintain our previous line of thought.¹

The Nature and Extent of Voluntary Power over the Movements of our Bodies.

The occasions for the exercise of voluntary movements of all kinds spring up, as I have pointed out, as ordinary links in the chain formed by the association of our ideas.

Sometimes simple voluntary movements occur with all the rapidity, ease, and lack of effort that characterize a so-called ideo-motor act, as when I resolve on certain occasions to sit or stand; to raise a glass of water to my lips when I am thirsty; or to eat when I am hungry. The initiatory causes of such actions are only a very little more complicated than those of simple spinal reflexes; the principal difference consisting, as Hartley long ago pointed out, in the fact that instead of being started by an external impression, they are initiated by ideas, although they may be more remotely prompted by internal or external impressions.²

¹ The view of Prof. Bain concerning the direct intervention of muscles in the control of our thoughts, is of course intimately dependent upon his particular view as to feelings of movement being in great part 'concomitants of the outgoing current' and being realized in motor centres. This naturally implies ideal recall in the same centres. Ferrier, strangely enough, though rejecting Bain's views in these latter respects, still adopts his derivative doctrine as to the scope of volition and the mode in which it effects control over our thoughts ("Functions of the Brain," 2nd Ed., p. 461). Ribot seems to show a similar inconsistency. He rejects Bain's notion concerning the mode of registration of muscular sense impressions ("Attention," pp. 66 & 71) and yet adopts his derivative views concerning the mode in which our thoughts are directed (*loc. cit.*, p. 64).

² There is, in fact, no line of demarcation to be found between the cerebral reflexes known as 'ideo-motor' acts, and simple or very familiar voluntary acts. It is often impossible to say which is the more appropriate designation for such acts. In regard to ideo-motor actions Müller said long

At other times our voluntary actions only take place after more or less complicated previous processes of deliberation, or weighing of motives, and with much or little sense of effort. As W. James says:¹—"In the dentist's chair, one idea is that of the manliness of enduring the pain, the other is that of its intolerable character. We assent to the manliness, saying 'let it be the reality,' and behold it becomes so, though with a mental effort exactly proportionate to the sensitiveness of our nerves. To the sailor on the wreck, one idea is that of the sore hands and the nameless aching exhaustion of his whole frame which pumping involves. The other is that of a hungry sea engulfing him. He says, 'rather the former,' and it becomes reality in spite of the inhibiting influence of the comparatively luxurious sensations of the spot in which he for the moment lies. . . . But in other cases both alternatives are images of mixed good and evil. Whatever is done has to be done against some inhibitory agency, whether of intrinsic unpleasantness in the doing, or of represented odiousness of the doing's fruits; the fiat has to occur against resistance. Volition then comes hand in hand with the sentiment of effort. . . . What does this effort seem to do? To bring the decisive volition. What is this Volition? The stable victory of an idea although it may be disagreeable, the permanent suppression of an idea although it may be immediately and urgently pleasant."

At the same time that ideas and motives are in this way in conflict, we have half-aroused or nascent images revived in other sensory centres representing the alternative actions or movements that would naturally be associated with this or that motive were it allowed to be operative. But it is only when one of these motives proves victorious—proves stronger, that is, than its rival—that all resistance is removed; we consent to its supremacy, and the result is

ago, "The idea of a particular motion, determines a current of nervous action towards the necessary muscles, and gives rise to the motion independently of the will." At times we may have the production of actions generally regarded as voluntary, taking place in this simple reflex fashion, and by aid of the same nervous mechanisms. This is also pointed out by Wundt (*loc. cit.* t. I., p. 443).

¹ "The Feeling of Effort," 1880, pp. 28 and 22.

that the revived image of its associated action becomes the immediate incitor of the real action which it foreshadowed.¹

Thus it happens that, in order to bring about some present or prospective pleasure, or the avoidance of some present or prospective pain, we feel a desire to perform certain definite movements, the ideas or images of such movements being aroused, as James Mill originally pointed out, as almost sub-conscious sensorial links in the chain of our thought processes.

From what has hitherto been said two important conclusions may be drawn. First, that a 'sense of effort' is associated with the conflict of ideas and motives which precedes the ascendancy of one of them; and that this sense of effort must, therefore, be an appanage of the activity of sensory centres and their annexes by the aid of which intellectual processes are carried on. There is no good reason for believing that the action of muscles has anything to do with the generation of this particular 'sense of effort'.²

Secondly, that the 'act of willing' any particular movement consists essentially in a consent (after the balancing of reasons that may exist for or against) to the occurrence of such a movement; the movement itself being at the time mentally prefigured by certain revived sensations—such revival representing, as James Mill said long ago, "the last part of the mental operation." The occurrence or not of the movement is to a certain extent an accident, and one which, when it occurs, lies altogether outside the mental process itself.

Let us look then now a little closer at these last links in the chain of association—that is at "the last part of the

¹ See Herbert Spencer, "Principles of Psychology," 1870, vol. I, p. 496.

² Another source of the sense of effort is intimately associated with the activity of our muscles. Its origin is to be found in the ingoing sensory impressions of various kinds whose termini and seats of registration are the kinaesthetic centres in each cerebral hemisphere. This is fully admitted by Wundt, though not by Bain, to be one source of the 'sense of effort.' Some confusion has, I think, lately been introduced into this already sufficiently complex subject by Waller in a paper entitled "The Sense of Effort: an Objective Study" (BRAIN, 1891, pp. 179-249). This title seems to me peculiarly unfortunate, in more ways than one. Interesting and carefully worked out as many of the experiments are, they do not seem to me to touch the question of the origin of the 'sense of effort' as the term is understood

mental operation" which leads on to the performance of a voluntary movement. It consists in a revival of the idea or conception of the movement to be executed. This idea has always at least a two-fold basis, though the actual production of the movement often requires a three-fold excitation of sensory centres in immediate succession, as I shall presently show.

For limb and trunk movements the idea is composed of revived visual and kinæsthetic impressions which have previously been received during the execution of similar movements. The reawakened activity of these sensory centres affords the necessary stimulus and guidance for the reproduction of the movement—the molecular actions associated with their excitation evoke, that is, the related suitable activity of motor centres in the spinal cord. So that as W. James puts it, "every representation of a motion awakens the actual motion which is its object, unless inhibited by some antagonistic representation simultaneously present to the mind." The same kind of thing happens in regard to speech movements, only here we have the reawakened activity of auditory in conjunction with kinæsthetic centres

by psychologists. I find therein no evidence to shake my opinions on this subject, and, moreover, find modes of stating my views to which I cannot assent. I hold that the functioning of muscle itself, of motor nerves, and of motor centres, are mere physiological processes devoid of subjective accompaniments; yet these are the structures in which Waller looks for after-effects that he assumes to be "the same as or similar to, or parallel with, the material substrata of the concomitant sensificatory phenomena" (p. 192). That is to say he seeks for the residual effects of what he says is variously termed "sense of effort," "muscular sense," "sense of movement," or "sense of innervation," in points along the track ABM of Fig. 1 (p. 81) with the whole of which, excepting one part, I say they have nothing directly to do. He seems to think that I consider the peripheral changes in this track as of most importance; while, as matter of fact, I say that the peripheral changes in muscle which he investigates, have nothing directly to do with any of these psychical phenomena. I hold that the contraction of muscles forms the occasion merely for the birth of a series of ingoing impressions starting from the peripheral ramifications of afferent nerves in muscles, joints, skin, &c., which are conveyed along the route MOA, and are consciously realized in the centre A. He calls this latter an efferent or motor centre, and thinks the psychical events he names above are dependent mainly upon its molecular activity. This is exactly what I have long since said, with the important exception, that I maintain the centre in question to be an afferent one (see p. 80). I find in Waller's paper no new independent evidence of any kind bearing upon this latter problem; and much in his mode of presenting the old evidence to which I cannot assent. His paper, in my opinion, must be taken solely as a contribution to what is known as "physiological fatigue"—as he, in fact, would seem to indicate by his sub-title.

starting the stimuli needful for calling into activity the proper motor centres for speech in the bulb.

I would only add here that this view of James Mill¹ is also the doctrine taught as to the mode of production of voluntary movements by Lotze² and by Herbert Spencer;³ that it has been advocated independently by W. James and myself since 1880; and later by Münsterberg,⁴ Horsley⁵ and others.

I have always considered that in the conjoint sensory

¹ *Ante*, p. 4.

² "Medicinische Psychologie," 1852.

³ "Principles of Psychology," 1st ed., 1855, p. 613, and 2nd ed., 1870, vol. I., p. 496.

⁴ Münsterberg's theory (see *Mind*, 1888, p. 468) concerning the 'muscular sense' and its relation to voluntary movements is identically the same as that published independently by Prof. James and myself in 1880, though this seems not to have been recognised by Croom Robertson, since he speaks (*Mind*, 1890, p. 525) of it "as mediating between the opposed theories that have thus far occupied the ground." His attempt in the same place to claim some justification for the view of Wundt and Bain seems to me not very successful. Thus he says (p. 527): "The difference on the afferent side of the system between sensation and representative image is allowed to be one that depends only or, at least, mainly, upon degree of excitation: this being (normally) greater when determined from the periphery. How, then, should there not be a corresponding difference of representative and presentative experience on the *effluent* side when the cerebral process in one case is not, and in the other is, effective in producing overt muscular contraction?" My answer to this is twofold. In the first place, I say that the centres to which his query refers do not stand on the *effluent* side of the nervous system; they (i.e., the kinæsthetic centres) are the cortical termini for a definite class of impressions, and, like the visual and the auditory, are true afferent centres (see p. 82). And, secondly, I would say that his analogical argument sets up a claim for subjective processes in association with the functioning of efferent centres, whilst I, in common with James, Münsterberg and others, maintain that no independent evidence exists to show that such functioning is ever by itself associated with a subjective phasis. His eyes are open to the possibility of this latter retort. He sees, in fact, that his analogy would be rendered nugatory by the denial of subjective phenomena in association with the functioning of motor centres—but he omits to mention that this heresy is maintained by James and Münsterberg as well as by myself. I fail to see, moreover, the cogency of his objections to the use of the term 'kinæsthesia,' and its derivatives. I would remind him that the term 'muscle sensation,' of which he seems to approve as an alternative, refers to only one element entering into the complexus of sensations produced in us whenever we make movements; and that the various components of this complexus are always simultaneously subject to revival as guides for future movements. Surely, if groups of impressions like this always occur together, and are always revived together for the carrying out of important physiological processes, that is a sufficient justification for speaking of them under some common name. And if we bear in mind the fact that such impressions, like all others, are when realized, as Croom Robertson points out, always "overlaid by representation," it may be seen that we are thereby enabled almost intuitively to interpret them as meaning movements of this or that part of our body. How could we, then, better convey the desired meaning than by speaking of them as 'kinæsthetic' impressions?

⁵ *The Nineteenth Century*, June, 1891, p. 857.

revivals, or 'ideas of movement,' the visual or the auditory impression, as the case may be, is the first to be revived, and that the renewed activity in one or other of these centres is passed on through associating fibres to functionally related portions of the kinæsthetic centres. The activity of these latter centres seems to me to be almost if not always evoked in this secondary manner, although for the actual production of the suitable movements the functioning of the kinæsthetic centres is all important. They are situated in the cortex at what has been termed the "bend of the stream"—they are indeed, the last portions of the cortex to be aroused in the performance of voluntary movements, and from them actually issue the fibres (*viz.*, those of the pyramidal tract), which convey the appropriate incitations to the real motor centres situated in the bulb and in the spinal cord.¹ Here then, as elsewhere, motor centres produce (through the intermediation of nerves and muscles) movements which are qualified as to nature, range, and force by the precise nature of the stimuli which they receive from sensory centres.²

How all important these sensory activities are for the production of voluntary movements is well shown in many cases of brain disease leading to speech defects. Thus, I have had under observation from time to time since 1878 a man who then became paralysed on the right side, and whose powers of expression by speech and writing were at the same

¹ I purposely, for the sake of simplifying the problems under discussion, omit all reference here to the co-operative action of the cerebellum in the actual production of movements.

² I am sorry that Dr. Ferrier has again not taken the trouble to state my views correctly. In his most recently published work he quite misrepresents them by stating that I have taught that the kinæsthetic centres are aroused as "independent centres of activity, irrespective of the stimuli from the sensory centres of the cortex" ("Cerebral Localization," 1890, p. 147). This supposed view of mine he then proceeds to refute by quoting the experiments of Marique, confirmed by Exner and Paneth, to the effect that "when the motor [kinæsthetic] centres have been completely isolated, by section of the fibres which associate them with the sensory centres of the cortex, paralysis results of precisely the same character as that which occurs when they are completely extirpated. Marique proved that the same contractions were obtainable on electrical irritation of the respective centres after, as before, isolation, showing that they still retained their excitability and connection with the pyramidal tracts." So far from being opposed to my views, it will be seen that these experimental results are in exact accordance with what I have always said in regard to the mode in which the activity of the kinæsthetic centres is evoked. See, for instance, "The Brain as an Organ of Mind," 1880, p. 593, and elsewhere; also *BRAIN*, Ap. 1887, pp. 7, 57, and elsewhere.

time disordered in a remarkable manner.¹ The principal persistent defect in this man has been a damage to the commissural or associating fibres connecting the visual and the auditory word centres, so that he is unable to perform any movements that require for their initiation and guidance the successive conjoint activity of these centres: showing how absolutely dependent our thought processes are upon the integrity of the associational paths. Thus, a blockage occurred twelve years ago in the lines of communication between the auditory and the visual centres; and as a consequence this man cannot name objects at sight, or read aloud words or even letters; though he recognises them perfectly, can read to himself with comprehension, and can repeat names of things, or words of any kind, immediately that he hears them. Again, though he has now learned to write with the left hand, and he can without hesitation copy in a rude way any words that are written on the paper before him, he cannot write a single word spontaneously or from dictation—not even a letter. The auditory stimulus will not pass along the blocked track,² so that there is no means of rousing the related portion of the visual centre or, consequently, of the kinæsthetic centre. Along this route the idea of writing movements cannot be revived, and as a result, the man cannot make even an attempt to form a single letter. But his puzzled look and passive state gives place to one of pleasure when he sees the word written, and he immediately proceeds to copy it; just as, in the previous trial, his eager tentative look at the word he seeks but is unable to articulate, is followed, the instant he hears it pronounced and thus receives an auditory revival, by its correct utterance. A block in the commissures connecting the auditory with the related glosso-kinæsthetic centre, would similarly prevent reading or naming at sight, as it would also prevent all spontaneous speech; and a block between the visual and the related cheiro-kinæsthetic centre

¹ His case is detailed in "The Brain as an Organ of Mind," p. 642.

² In silent thought, and therefore for spontaneous writing also, the first memory of the word to be revived is, I believe, in the great majority of persons, that which is registered in the auditory centre.

would similarly render writing from dictation, or spontaneous writing, impossible.¹

Here, then, we get at the very roots of Will. The sources of the power employed for arousing the appropriate contractions of our muscles is to be found in the molecular activities issuing from these sensory centres. This is shown by the fact that we have in such cases as I have above referred to, persons 'willing' but unable to successfully execute certain speech movements at the instigation of appropriate visual impressions, though they retain the power of producing such movements in response to appropriate auditory stimuli; and, on the other hand, persons unable to produce writing movements at the instigation of auditory stimuli, which they are able at once to evoke at the bidding of visual impressions.

The same kind of conclusion, as to the source of the energy employed in the production of muscular movements generally, has been forced upon Gotch and Horsley, during their recent important electrical investigations concerning the excitability of different regions in the brain and spinal cord, which in 1890 formed the subject of the Croonian Lecture before the Royal Society.² I note, however, that even these investigators speak of the cerebral kinæsthetic centres as being on the "efferent" side of the nervous system.³ This seems to me an erroneous interpretation. They are, I think, afferent centres in every way analogous to the afferent centres situated in the spinal cord.⁴ The so-called "motor centres" of the cortex were not, of course, originally supposed to be termini for afferent impressions; when first discovered they were said, and they are still maintained by Ferrier to be, true "motor centres." Now, however, in spite of the different interpretation which has been given of their functions, many still cling to the belief that the centres in the Rolandic area must be motor centres because internuncial fibres connect them with the real motor centres in the bulb and spinal cord—and because, therefore, 'motor incitations' must pass along

¹ See a paper "On Different Kinds of Aphasia," *Brit. Med. Journ.*, Oct. 29th and Nov. 5th, 1887.

² *Phil. Trans.* 1891, B, pp. 447, 449, 478 & 509.

³ *Loc. cit.*, p. 342.

⁴ *Loc. cit.*, p. 479.

such internuncial fibres.¹ "What initiates a motor process" they say,² "is to all intents and purposes motor." Or, as Ferrier³ puts it, "centres immediately concerned in effecting voluntary movements" are "as such motor." Both these

FIG. 1.

FIG. 2.

FIG. 1.—Diagram illustrating the origin of kinesthetic impressions (so far as they come from muscle) and their relation to the production of voluntary movements, in accordance with my views.

A. Cerebral afferent (kinesthetic) centre, receiving and registering ingoing impressions from muscle by way of an afferent spinal centre C; *i.f. i.f.*, two sets of internuncial fibres; B, spinal efferent or motor centre, which receives incitations from A, whence they are sent on to the muscle M.

∴ A is an afferent centre in the same sense that C is an afferent centre and each of them may initiate 'motor incitations' which pass along internuncial fibres to the motor centre B.

FIG. 2.—Diagram illustrating the origin of muscular sense impressions and their relation to the production of voluntary movements, in accordance with the views of Dr. Ferrier.

A. Cerebral afferent (tactile) centre receiving and registering ingoing impressions from muscle by way of an afferent spinal centre C; A' a supposed motor centre, which operates through commissural fibres upon the spinal motor centre B.

∴ No psychical processes are believed by either of us to be associated with the functional activity of the tracks represented by unbroken lines and the centres lying in their course.

I say that the functions attributed by Ferrier to A' are really performed by A as in Fig. 1, and that if A, A' existed as in Fig. 2, there ought to be two sets of excitable areas in each hemisphere.

¹ Since 1880 I have always restricted the term 'internuncial' to fibres which connect an afferent with an efferent centre; employing the term 'commissural' to those fibres that connect two afferent or two efferent centres with one another. (See "Brain as an Organ of Mind," p. 586).

² W. L. Mackenzie, in *BRAIN*, 1887, p. 433.

³ "Functions of the Brain," 2nd Ed., p. 848.

statements I believe to be altogether erroneous. As I have said elsewhere,¹ "The plan on which nervous centres generally are constructed, of whatsoever grade, makes it essential that the stimulus which awakens the activity of a 'motor' ganglion or centre shall come to it through connecting fibres from a 'sensory' ganglion centre, or knot of cells—that is, from cells which stand in immediate relation with ingoing fibres." Thus, we should not call a cortical centre for afferent impressions 'motor,' any more than we should call the group of ganglion cells on the afferent side of a spinal reflex arc 'motor.' In each case the nerve cells that receive the afferent impulses are in association with channels which convey 'motor incitations'; and in each case the stimulation of such internuncial fibres or of the centres from which they proceed would give birth to definite movements. The course of these internuncial fibres is for the most part horizontal in the spinal cord, though more rarely it may be an ascending one. But from the kinæsthetic centres in the brain the course of the internuncial fibres is downwards (in the pyramidal tract); hence the current is commonly spoken of, truly enough, as an "out-going current"; but with the effect, apparently, of fostering some confusion in the minds of not a few persons. It was apparently under the influence of some such confusion that W. L. Mackenzie,² a writer above quoted, penned the following sentences. If "we confine consciousness to sensory processes, then since sensory may excite motor processes, we must imagine consciousness suddenly ceasing on the nervous bridge—the internuncial fibres—between a sensory and a motor centre. If this be so the time has come for abolishing altogether the distinction of sensory and motor cortical centres; they are all sensori-motor." This seems to me to be an invalid conclusion, based upon a misconception as to the mode in which motor centres generally are stimulated. Certainly, there is no more reason why centres on the afferent side of the nervous system which happen to be situated in the cortex should be called 'sensori-motor,' than that such a term

¹ "The Brain as an Organ of Mind," p. 585.

² *Loc. cit.*, p. 432.

should be applied to similar afferent centres situated in the spinal cord. And yet it would be only upon such a basis that justification could be found for the oft-quoted view of Hughlings Jackson, cited by the same author (*loc. cit.*, p. 432) "that the physiological substratum of every mental process is a sensori-motor process."

From what has now been set forth, as well as from the facts and arguments detailed in a previous communication to this Society,¹ it seems to me quite clear that there is no reason for postulating the existence of cortical motor centres for the production of voluntary movements; that whatever the mode in which simple movements are produced, that is, whether they are voluntary or reflex, only one set of motor centres is called into play, and that these motor centres are situated in the bulb and in the spinal cord; and, further, that the functioning of motor centres generally is attended by no psychical accompaniments. In reference to this last point I have said elsewhere:²—"No ideal reproductions seem ever to take place in such centres; they are roused into activity by outgoing currents, and, so far as we have any evidence, the induction in them of molecular movements which, immediately afterwards, issue through cranial and spinal motor nerves to muscles are simply physical phenomena. These processes are apparently as free from subjective accompaniments as are the actual molecular processes thereby incited in the muscle itself." In fact the molecular motions that occur in motor centres "seem to lie even more truly outside the sphere of Mind than the molecular processes comprised in the actual contraction of a muscle; these latter are at least immediately followed by 'ingoin' impressions, whilst so far as we know—that is so far as any evidence exists—the former are not."

On the other hand, in common with James, and in part with Münsterberg and others, I maintain, that all the sensations resulting from movement are derived from ingoin

¹ "The 'Muscular Sense;' its Nature and Cortical Localisation," *BRAIN*, April, 1887.

² "The Brain as an Organ of Mind," p. 599. The lack of sensibility accompanying the action of motor centres has now been experimentally demonstrated by Gotch and Horsley (*loc. cit.* p. 510).

impressions; that such sensations are realized and revivable in idea in special sensory centres in the Rolandic area of the cortex, which are in intimate associational relation with visual, auditory, and other sensory centres; that the functional activity assumed to be performed by voluntary motor centres in the Rolandic area is really carried out by these sensory centres of kinæsthetic type, similarly located; so that in "the association of ideas" generally, as well as in the processes of Attention and Volition we have merely to do with the psychical activity of sensory centres and their annexes—and not of motor and sensory centres, with the former often dominating. Thus I hold that the process of Attention is in its essence sensory, though with inseparable motor accompaniments; while Volition, so far from "existing only in connection with the active organs, that is, with the muscular system," seems to represent merely some phases in the "association of ideas" and, as W. James puts it, is rather "a psychic or moral fact pure and simple, and is absolutely completed when the intention or consent is there"—he also maintaining that the supervention of motion upon its completion is a supernumerary phenomenon belonging to the department of physiology. The phenomena of Volition are, therefore, not the work of any special faculty or mysterious entity, nor are they carried on in motor centres; they are merely certain exemplifications of intellect in action; so that ample justification is found for the dictum of Spinoza, "*Voluntas et intellectus unum et idem sunt.*" Anything separate to be known as Will, is, in fact, a mere phantom—a kind of psychological ghost.

¹ Bain, "The Senses and the Intellect," 3rd. Ed., p. 559.