ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, AUGUST 23-29

(For the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on August 23

Sun rises, 5h. 0m.; souths, 12h. 2m. 22·7s.; sets, 19h. 5m.; decl. on meridian, 11° 19′ N.: Sidereal Time at Sunset, 17h. 14m.

Moon (Full on August 25) rises, 17h. 49m.; souths, 22h. 40m.; sets, 3h. 38m.*; decl. on meridian, 13° 55′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	6 54	13 1	19 8	0 41 N.
Venus	7 46	13 54	20 2	0 50 N.
Mars	0 41	8 56	17 11	23 18 N.
Jupiter	6 8	12 50	19 32	7 41 N.
Saturn	0 8	8 17	16 26	22 26 N.

* Indicates that the setting is that of the following day.

Occultations of Stars by the Moon

August	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
26	67 Aquarii	6	5 9	6 9	151 325
27	B.A.C. 8365	6½	20 48	near approach	162 —

The Occultations of Stars are such as are visible at Greenwich.

August	h.	
27	11	Mercury in conjunction with and 6° 1′ south of Jupiter.

THE MOTOR CENTRES OF THE BRAIN AND THE MECHANISM OF THE WILL[1]

FEELING deeply as I do the responsibility I have incurred in undertaking to address you to-night, I desire to express my regret that I cannot instead share with you the pleasure of listening to the distinguished man who has been prevented by a most painful bereavement from addressing you to-night.

My subject being the mechanism of the will, it might be asked, "What has a surgeon to do with psychology?" To which I would answer, "Everything." For without sheltering myself behind Mr. Jonathan Hutchinson's trite saying that "a surgeon should be a physician who knows how to use his hands," I would remind you that pure science has proved so good a foster-mother to surgery, that diseases of the brain which were formerly considered to be hopeless, are now brought within a measurable distance of the knife, and therefore a step nearer towards cure. Again, I would remind you that surgeons rather than physicians see the experiments which so-called Nature is always providing for us,—experiments which, though horribly clumsy, do on rare occasions, as I shall presently show you to-night, lend us powerful aid in attempting to solve the most obscure problems ever presented to the scientist.

The title I have chosen may possibly be objected to as too comprehensive; but until we are ready to admit a new terminology we must employ the old in order to convey our meaning intelligibly, although there may be coupled therewith the risk of expressing more than we desire. Thus when I speak of the mechanism of the will and the motor centres of the brain, I do not intend (as indeed must be obvious) to discuss the existence of the so-called freedom of the will, or the source of our consciousness of voluntary power.

I shall rather describe to you first the general plan of the mechanism which conveys information to our brain, the thinking organ; next the arrangement of those parts in it which are concerned with voluntary phenomena; and finally I shall seek to show by means of experiment that the consciousness of our existing as single beings, the consciousness of our possessing but one will as people say, while at the same time we know that we possess a double nervous system, is due to the fact that pure volition is dependent entirely on the exercise of the attention which connotes the idea of singleness. Consequently that it is impossible to carry out two totally distinct ideas at one and the same moment of time, when the attention must of course be fully engaged upon each.

[1] Lecture at the Royal Institution of Great Britain by Victor Horsley, F.R.C.S.

I fear that in making my argument consecutive, I shall have to pass over very well-beaten paths, and so I must ask your patience for a few moments while I make good my premisses.

The nervous system, which in man is composed of brain, spinal cord, nerves, and nerve-endings, is arranged upon the simplest plan, although the details of the same become highly complex when we arrive at the top of the brain.

At the same time, while we have this simple plan of structure, we find that there is also a fundamental mode of action of the same—a mode which is a simple exposition of the principle, no effect without a cause—a mode of action which is known as the phenomenon of simple reflex action.

The general plan of the whole nervous system is illustrated by this model. Imbedded in the tissues all over the body, or highly specialised and grouped together in separate organs, such as the eye or ear, we find large numbers of nerve-endings,—that is, small lumps of protoplasm from which a nerve-fibre leads away to the spinal cord and so up to the brain.

These nerve-endings are designed for the reception of the different kinds of vibration by which energy presents itself to us. As the largest example of these nerve-endings, let me here show you one of the so-called Pacinian bodies, or more correctly, Marshall's corpuscles, for Mr. John Marshall discovered these bodies in England before Pacini published his observations in Italy. Here you see one of these small oval bodies arranged on the ends of one of the nerves of the fingers, and here you see the nerve-fibre ending in the little protoplasmic bulb which is protected by a number of concentric sheaths.

Pressure or any form of irritation of this body at the end of the nerve-fibre causes a stream of nerve-energy to travel through the spinal cord to the brain, and so we become conscious that something is happening to the finger.

Here in this section of the sensitive membrane of the back of the eye, the retina, you see a similar arrangement, only more complicated,—namely, nerve-fibres leading away from small protoplasmic masses which possess the property of absorbing light and transforming it into nerve-energy. It is this transformation of nerve-energy into heat, light, pressure, &c., which it seems to me should alone be called a sensation, irrespective of consciousness. And in fact we habitually say we *feel* a sensation. The terms "feeling" and "sensation," however, are frequently used as interchangeable expressions, although, as I shall show you directly, "feeling" is the conscious disturbance of a sensory centre in the surface of the brain, and in fact feeling is the conscious perception of sensations. This distinction between feeling and sensation, if dogmatic, will save us from dispute as to the meaning of the word "sensation"; and further, the distinction is one, as I have just shown, which is justified by custom.

Now the nerve fibre which conveys the energy of the sensation is a round thread of protoplasm which in all probability connects the nerve-ending with a sensory corpuscle in the spinal cord. These nerve-fibres running in nerves are white, whereas, as you know, protoplasm is gray. They are white because each is insulated from its fellow by a white sheath of fatty substance, just as we protect telegraph wires with coatings. It is not stretching analogy too far to say that nerve-force may probably escape unless properly insulated.

In consequence of the fibres being covered with these white sheaths, they form what is called the white matter of the brain; while the nerve centres are grayish, and therefore form what is called the grey matter of the brain, so that the grey matter receives and records the messages conveyed to it by the white insulated fibres.

From the sensory corpuscle, which is a small mass of protoplasm provided with branches connecting it to neighbouring corpuscles, the nerve energy, if adequate, passes along a junction thread of protoplasm to a much larger corpuscle, which is called a motor corpuscle, and the energy of which, when liberated by the nerve impulse from the sensory corpuscle, is capable of exciting muscles into active contraction. These two corpuscles form what is called a nerve centre.

Not only are the motor corpuscles fewer as well as much larger than the sensory ones, but also the nerve fibres which go out from them are larger too. In fact it would seem as if we had another close analogy to electrical phenomena; for here, where we want a sudden discharge of a considerable intensity of nerve force, we find to hand a large accumulator mechanism and a large conductor, the resistance of which may justly be supposed to be low. Finally, the motor nerve-fibre terminates in a protoplasmic mass which is firmly united to a muscle fibre, and which enables the muscle fibre to contract and so cause movement of one or more muscles. Now, with this idea of the general plan on which the whole nervous system is constructed, you will understand that muscular action, *i.e.* movement, will occur in proportion to (1) the intensity of the stimulation of the sensory corpuscle; and (2) the resistance in the different channels. When a simple flow through the whole apparatus occurs, it is called a simple reflex action, and this was discovered in England by Dr. Marshall Hall.

To recapitulate: a nerve centre, theoretically speaking, we find to consist of a sensory corpuscle on the one hand and a motor corpuscle on the other, both these being united by junction threads or commissures. To such a centre come sensations or impressions from the nerve-endings, and from such a centre go out impulses which set the muscles in action.

I have dwelt thus at length on this most elementary point, because it appears to me that, in consequence of the rapidity with which function is being demonstrated to be definitely localised in various portions of the cerebral hemispheres, we are in danger of losing sight of Dr. Hughlings Jackson's grand generalisations on nerve function, and that we are gradually inclining to the belief that the function of each part is very distinct, and therefore can most readily act without disturbing another part.

In fact, we are perhaps drifting towards the quicksands of spontaneity, and disregarding entirely the facts of every-day life which show that every cycle of nerve action includes a disturbance of the sensory side as well as the active motor agency. Did we in fact admit the possibility of the motor corpuscle acting *per se*, and in the absence of any sensory stimulation we should again be placed in the position of believing that an effect could be produced in the absence of a cause.

For these reasons such a centre has been termed kinæsthetic or sensori motor, and such centres exist in large quantities in the spinal cord, and they perform for us the lower functions of our lives without arousing our consciousness or only the substrata of the same.

But now, turning to the brain, although I am extremely anxious to maintain the idea just enunciated that, when discussing the abstract side of its functions we should remember the sensori motor arrangement of the ideal centre, I shall have to show you directly that the two sides—namely, the sensory and motor—in the brain are separated by a wide interval, and that in consequence we have got into the habit of referring to the groups of sensory and motor corpuscles in the brain as distinct centres. I trust you will not confuse these expressions, this unfortunately feeble terminology, and that you will understand, although parts may be anatomically separated and only connected by commissural threads, that functionally they are closely correlated.

In consequence of the bilateral symmetry of our bodies we possess a double brain—a practically symmetrical arrangement of two intimately connected halves or hemispheres which, as you know, are concerned with opposite sides of the body, for the right hemisphere moves the left limbs, and *vice versâ*.

For my purpose it will be sufficient if we regard the brain as composed of two great collections of gray matter or nerve corpuscles which are connected with sensory nerve-endings, with muscles, and intimately with one another.

In this transverse section of a monkey's brain, which is stained dark blue to show up its component parts, you will see all over the surface a quantity of dark gray matter, which is simply the richly convoluted surface of the brain cut across. Observe it is about a quarter of an inch deep, and from it lead downwards numerous white fibres down towards the spinal cord. The surface of the brain, the highest and most complicated part of the thinking organ, is called the cortex, bark, or rind, and in it are arranged the motor centres I am about to describe. These white fibres coming away from it to the cord, not only are channels conveying messages down to the muscles, but also carrying messages from the innumerable sense corpuscles all over the body.

So much for one grey mass of centres. Now down here at the base of the brain you see two lumps or masses of the same nature, and these are called, therefore, the basal ganglia or grey masses. Since they are placed at the side of the paths from the cortex, and undoubtedly do not interfere with the passage of impulses along those paths, we may put them aside, remembering that they probably are concerned with low actions of the nervous system, such as eating, &c., which are popularly termed automatic functions.

In this photograph of a model made by Prof. Aeby, of Berne, you see represented from the front the two cerebral hemispheres with the centres in the cortex as little masses on the surface, and the basal ganglia as darker ones at the bottom, while leading from them down into the spinal cord are wires to indicate the channels of communication.

Note, in passing, that both hemispheres are connected by a thick band of fibres called the "corpus callosum." It is, I believe, the close union thus produced between the two halves that leads in a great measure (though not wholly) to consonance of ideas.

The arrangement of the fibres will be rendered still clearer by this scheme, in which the cortex is represented by this concave mass, and the fibres issuing from the same by these threads.

The basal ganglia would occupy this position, and they have their own system of fibres.

I will now leave these generalisations, and explain at once the great advance in our knowledge of the brain that has been made during the last decade. The remarkable discovery that the cortex or surface of the brain contained centres which governed definite groups of muscles, was first made by the German observers Hitzig and Fritsch; their results were, however, very incomplete, and it was reserved for Prof. Ferrier to produce a masterly demonstration of the existence and exact position of these centres, and to found an entirely new scheme of cerebral physiology.

The cortex of the brain, although it is convoluted in this exceedingly complex manner, fortunately shows great constancy in the arrangement of its convolutions, and we may therefore readily grasp the main features of the same without much trouble.

From this photograph of the left side of an adult human brain you will see that its outer surface or cortex is deeply fissured by a groove running backward just below its middle, which groove is called the "fissure of Sylvius," after a distinguished mediæval anatomist. This fissure, if carried upwards, would almost divide the brain into a motor half in front and a sensory half behind.

Of equal practical importance is another deep fissure which runs at an open angle to the last, and which is called the "fissure of Rolando," Rolando being another pioneer of cerebral topography. Now it is around this fissure of Rolando that the motor side of the centres for voluntary movement is situated; and when this portion of the cortex is irritated by gentle electric currents, a constant movement follows according to the part stimulated.

Because of their upward direction, the convolutions bounding the fissure of Rolando are called respectively the "ascending frontal" and "ascending parietal" convolutions.

Now here, at the lowest end of the fissure of Rolando, we find motor areas for the movement of both sides of the face: that is to say that, as regards this particular piece of the cortex, it has the power of moving not only its regular side of the face, the right, but also the left—that, in fact, both sides of the face move by impulse from it.

Higher up we find an area for movement of the opposite side of the face only. I reserve for a moment the description of this portion of the brain, and pass on to say that above these centres for the face we find the next is for the upper limb, and most especially the common movement of the upper limb—viz. grasping, indeed the only forward movement which the elbow is capable of, namely, flexion. The grasping and bringing of an object near to us is the commonest movement by far, and we find here that this centre is mainly concerned in it. Behind the fissure of Rolando Dr. Ferrier placed the centres for the fingers.

Next above the arm area is a portion of the cortex which moves the lower limb only, and in front of this again is an area for consonant action of the opposite arm and leg.

Let me here remind you that this being the left hemisphere, these are the centres for movement of the opposite, that is, the right limbs, and that in the other hemisphere there are corresponding areas for the left limbs.

Thus here we have mapped out those portions of the cortex which regulate the voluntary movement of the limbs. So far I have omitted mention of the muscles of the trunk, namely, those which move the shoulders, the hips, and bend and straighten the back. Dr. Ferrier had shown that there existed on the outer surface of the cortex, here, a small area for the movement of the head from side to side.

Prof. Schäfer and myself have found that the large trunk muscles have special areas for their movement, ranged along the margin of the hemisphere, and dipping over into the longitudinal fissure. Thus all the muscles of the body are now accounted for, and I will first draw special attention to the fact that they are arranged in the order, from below upwards, of face, arm, leg, and trunk.

The consideration of this very definite arrangement led Dr. Lauder Brunton to make the ingenious suggestion that it followed as a necessary result of the progressive evolution of our faculties. For premising, in the first place, from well-ascertained broad generalisations that the highest centre, physically speaking, is also the highest functionally and most recent in acquirement, we find that the lowest is the face, and then we remember that the lowest animals simply grasp their food with their mouth. I imagine it is scarcely necessary for me to repeat the notorious confession that our faculties are arranged for the purpose of obtaining food as the primary object of what is called bare existence.

Proceeding upwards in the scale of evolution we next find animals which can grasp their prey and convey it to the mouth, and so we find next to the face area evolved that for the arm.

And so on, the next step would be the development of the legs to run after the prey, and here is the leg centre; while, finally, the trunk muscles are dragged in to help the limbs more effectually.

To my mind this idea receives overwhelming support from the consideration of the fact that, the higher our centres are the more they require education; the infant, for instance, in a few days shapes its face quite correctly to produce the food-inspiring yell, yet takes months or years to educate its upper limbs to aid it in the same laudable enterprise. Finally, what terrible probation some people pass through at the hands of dancing-masters before their trunk muscles will bend into the bow of politeness.

Now to return to the lower end of the fissure of Rolando, to the areas for movements of the face; it was long ago pointed out by the two Dax's and Prof. Broca that when this portion of the brain immediately in front of the face area was destroyed, that the person lost the power of articulate speech, or was only capable of uttering interjections and customary "strange oaths."

In fact this small portion of the left side of our brains (about 1½ square inches) is the only apparatus for expressing our thoughts by articulating sounds, and note particularly that it is on the left side. The corresponding piece on the right side cannot talk as it were. This remarkable state of things is reversed in left-handed people. In these the right hemisphere predominates; and so we find that when this portion was diseased, there followed aphasia, as it is called. While, however, the right side customarily says nothing, it can be taught to do so in young people, though not in the aged.

Before leaving these motor areas, let me repeat, by way of recapitulation, that the only truly bilaterally acting areas are those for the lower facial and throat muscles. This is a most important fact, for the idea has recently been propounded that both sides of the body are represented in each motor region of each hemisphere. That is to say, each motor area has to do with the movements of both upper limbs, for example. In support of my contention that this is not in accordance with clinical facts, let me here show you photographs of the brain of a man who was unfortunate enough to suffer destruction of the fibres leading from one motor area. Here you see a puncture in the brain which has caused hæmorrhage beneath the fissure of Rolando and the motor convolutions in front and behind it.

In this transverse section of the same spot you see that the hæmorrhage has ploughed up the interior of the brain. Here is the cortical grey matter, but its fibres leading down to the muscles are all destroyed.

Now in examining this patient I asked him to move his left arm or leg; he was perfectly conscious, and, understanding the question, made the effort as we say, but no movement occurred.

Now if both sides of the body are represented in each hemisphere, it seems to me that such a case would be impossible, or at least that a little practice would enable the other hemisphere to do the work; but all clinical facts say that, once destroyed, the loss is never recovered.

If we examine this motor region of the cortex with the microscope we of course find these large corpuscles, which we have learnt are those which alone give energy to the muscles.

But you must not imagine that the motor region consists solely of these corpuscles. On the contrary, as you see in this diagram, we have several layers of corpuscles. I shall return to this arrangement of the corpuscles directly.

Looking back at the surface of the brain you notice that I have only accounted for but a small portion of the cortex. Dr. Ferrier was the first to show that the portion of cortex which perceived (and I use the word in its strictest sense) the sensation of light was this part, and it is therefore called the "visual centre or area." From recent researches it would appear that we must give it the limits drawn on this diagram. Below it we find the centre for hearing.

Thus we know where two sense perceptive centres are situated.

Microscopical investigation shows that this sensorial portion of the cortex is very deficient in large corpuscles, and is correspondingly rich in small cells. Here in this diagram you see these two kinds of structure in the cortex cerebri. Note the greater number and complication of the small corpuscles in the sensory part of the cortex, and the comparatively fewer though much larger corpuscles in the motor region.

It seems to me that several beliefs are justified by these facts.

In the first place the movements produced by the action of these motor centres are always the same for the same centre; consequently it has only one thing to do, one idea as it were. Thus, for instance, bending of the arm: this action can only vary in degree, for the elbow will not permit of other movements. Hence we may look upon it as one idea. Now observe that where one idea is involved, we have but few corpuscles.

Next consider the multitude of ideas that crowd into our mind when we receive a sensation. One idea then rapidly calls up another, and so we find anatomically that there are a corresponding much greater number and complication of nerve-corpuscles.

To sum up, I believe we are justified in asserting that where in the nervous system a considerable intensity of nerve-energy is required—(*e.g.*, for the contraction of muscles)—you find a few large corpuscles and fibres provided, and that where numerous ideas have to be functionalised there numerous small corpuscles are arranged for the purpose.

But now the special interest attaching to the sensory perceptive areas is that they, unlike the motor areas, tend to be related to both sides of the body. With our habit of constantly focussing the two eyes on one object, it will strike you at once that habitually we can only be attentively conscious of one object at a time, since both eyes are engaged in looking at it, and, as you know, we cannot as a matter of fact look at two things at once.

Hence I take it, both sensory perceptive centres are always fully occupied with the same object at the same moment, and that therefore we have complete bilateral representation of both sides of the body in each hemisphere. As a further consequence, each sensory perceptive area will register the idea that engaged it; in other words, both centres will remember the same thing. Thus it happens that each sensory area can perform the duty of the other, and therefore it is a matter of comparative indifference whether one is destroyed or not, and as a matter of fact when this happens we find that the person or animal recognises objects as they actually are, and in fact has no doubt as to their nature. Here you see anatomically the reason of this peculiarity is found to be that the optic or seeing nerves cross one another incompletely in going to each hemisphere, and thus each sensory centre represents half of each eyeball.

I must pass rapidly to the description of the rest of the surface of the brain—the hinder and front ends. At the outset I must admit that all our knowledge concerning them is very hypothetical in the absence of positive experimental results.

This much we can say, that they are probably the seats of intellectual thought, for many reasons which I have not time to detail. Further, we know that these intellectual areas are dependent for their activity entirely on the sensory perceptive centres, for the dictum that there is no consciousness in the absence of sensory stimulation is very well established, as I shall now show you, however astounding it may appear. In the first place, you will remember that when we wish to encourage that natural loss of consciousness which we call sleep, we do all we can to deprive our sense-organs and areas of stimulation; thus we keep ourselves at a constant temperature, we shut off the light, and abolish all noises if we can. But a most valuable observation was made a few years ago by Dr. Strümpell, of Leipzig, who had under his care a youth, the subject of a disease of the brain, &c., which, while destroying the function of one eye and ear, besides the sensibility to touch over the whole body, still left him when awake quite conscious and able to understand, &c., using his remaining eye and ear for social intercourse. Now when these were carefully closed he became unconscious immediately, in fact slept, and slept until he was aroused again, or awoke naturally as we say after some hours.

Hence the higher functions of the brain exercised when that organ is energising the reasoning of the mind, are absolutely dependent upon the reception of energy from the sense perceptive areas.

But my only point with reference to this part of the brain is to attempt to determine how far they are connected with the motor centres in the performance of a voluntary act. With the mechanism of choice and deliberate action I have nothing to do, but there can be no doubt that the part of the brain concerned in that process of the mind is directly connected with the motor region, as indicated on this diagram, to which I would now return. From what I have here written you read, arranged schematically, the psychical processes which for the sake of argument we may assume are carried on by the mind in these portions of the cortex.

I wish to point out that we have structurally and physiologically demonstrated with great probability the paths and centres of these psychical actions. There is no break: the mere sight of an object causes a stream of energy to travel through our sense areas, expanding as it goes by following the widening sensory paths here represented, and at the same time we feel our intellect learns that new ideas are rising up and finally expand into the process of deliberate thought, concerning which all we know is from that treacherous support, namely introspection.

Then comes impulses to action, and these follow a converse path to the receptive one just described; the nerve energy is concentrated more and more until it culminates in the discharge of the motor corpuscles. We might represent the whole process of the voluntary act by two fans side by side, and the illimitable space above their arcs would serve very well to signify the darkness in which we sit concerning the process of intellectual thought.

What I have hastily sketched is the outline of the process of an attentive or voluntary act. I say attentive advisedly, for I wish now to put forward the view that the proper criterion of the voluntary nature of an act is not the mere effort that is required to perform it, but is the *degree to which the attention is involved*. The popular view of the volitional character of an act being decided by the effort to keep the action sustained is surely incomplete, for in the first place we are not seeking to explain our consciousness of an effort, we endeavour to discover the causation of the effort. Our sense of effort only comes when the will has acted, and that same sense is no doubt largely due to the information which the struggling muscle sends to the brain, and possibly is a conscious appreciation of how much energy this motor corpuscle is giving out.

Now to give you an example. I see this tambour, and decide to squeeze it, and do so. Now this was a distinctly voluntary act; but the volitionary part of it was not the effort made, it was the deliberate decision to cause the movement.

I may now point out that in this whole process we say, and say rightly, that our attention is involved so long as we are deliberating over the object, that as soon as another object is brought to us our attention is distracted, that is to say, turned aside.

All writers are agreed that the attention cannot be divided, that we really only attend to one thing at once.

It seems to me that this is so obvious as not to require experimental demonstration, but I have led up to this point because I now wish to refer to the third part of my subject, namely, the question as to whether we have a really double nervous system or not; but by way of preface let me repeat that although we may have a subconsciousness of objects and acts, that that subconscious state is true automatism, and that such automatic acts are in no sense voluntary until the attention has been concentrated upon them. For example, again I press this tambour because I desire to raise the flag, and I keep that raised while I attend to what I am saying to you. My action of keeping the flag raised is only present to my consciousness in a slight or subordinate degree, and does not require my attention, deliberate thought or choice, and therefore, I repeat, is not a voluntary action, in fact it could be carried on perfectly well by this lower sensori motor centre, which only now and then sends up a message to say it is doing its duty, in the same way as a sentry calls out "All well" at intervals.

But to return. In consequence of the obvious fact that we have two nerve organs, each more or less complete, some writers have imagined that we have two minds; and to the Rev. Mr. Barlow, a former secretary of this Institution, is due the credit of recognising the circumstances which seem to favour that view. It was keenly taken up, and the furore culminated in a German writer (whose name I am ashamed to say has escaped me) postulating that we possess two souls.

Now the evidence upon which this notion rests, that the two halves of the brain might occasionally work independently of one another at the same moment, was of two kinds. In the first place it was asserted that we could do two different things at once, and in the second place evidence was produced of people acting and thinking as if they had two minds.

Now, while of course admitting that habitually one motor centre usually acts at one moment by itself, I am prepared to deny *in toto* that two voluntary acts can be performed at the same time, and I have already shown what is necessary for the fulfilment of all the conditions of volition, and that these conditions are summed up in the word attention.

Further, I have already shown that when an idea comes into the mind owing to some object catching the eye, that both sensory areas are engaged in considering it. It seems to me I might stop here, and say that here was an *à priori* reason why two simultaneous voluntary acts are impossible; but as my statements have met with some opposition, I prefer to demonstrate the fact by some experiments.

The problem, stated in physiological terms, is as follows:—

Can this right motor region act in the process of volition, while at the same time this other motor area is also engaged in a different act of volition?

Some say this is possible; but in all cases quoted I have found that subconscious or automatic actions are confused with truly voluntary acts. I mean that such automatic acts as playing bass and treble are not instances of pure volition, as the attention is not engaged on both notes at once.

Consider for a moment the passage of the nerve impulses through the brain that would have to occur. At the outset we find that the sensory perceptive centres would have to be engaged with two different ideas at once; but Lewes showed long ago that introspection tells us this is impossible, that "consciousness is a seriated change of feelings," he might equally well have said ideas. And again, we know that when two streams of energy of like character meet one another, they mutually arrest each other's progress by reason of interfering with the vibration waves.

I will show directly that this is actually the case in the action of the cortex when the above-mentioned dilemma is presented to it.

The experiment I have devised for this purpose is extremely simple.

A person who is more or less ambidextrous, and who has been accustomed for a long time to draw with both hands, attempts to describe on a flat surface a triangle and circle at the same moment. I chose these figures, after numerous trials, as being the most opposite, seeing that in a triangle there are only three changes of movement, while in a circle the movement is changing direction every moment. To ensure the attempt to draw these figures simultaneously succeeding, it is absolutely necessary that the experimenter should be started by a signal.

When the effort is made there is a very definite sensation in the mind of the conflict that is going on in the cortex of the brain. The idea of the circle alternates with that of the triangle, and the result of this confusion in the intellectual and sensorial portions of the brain is that both motor areas, though remembering, as it were, the determination of the experimenter to draw distinct figures, produce a like confused effect, namely, a circular triangle and a triangular circle. If the drawing is commenced immediately at the sound of the signal it will be found that the triangle predominates; thus, if I determine to draw a triangle with my left hand and a circle with my right, the triangle (though with all its angles rounded off) will be fairly drawn, while the circle will be relatively more altered, of course made triangular. On the other hand, if the two figures are not commenced simultaneously, it will be found that usually the one begun last will appear most distinct in the fused result, in fact will very markedly predominate.

Now the course of events in such an experiment appears to be clear.

The idea of a triangle and circle having been presented to the intellect by the sensory centres, the voluntary effort to reproduce these is determined upon. Now, if we had a dual mind, and if each hemisphere was capable of acting *per se*, then we should have each intellectual area sending a message to its own motor area, with the result that the two figures would be *distinct* and *correct*, not fused.

The other evidence that I referred to above, which is adduced in favour of the synchronously independent action of the two hemispheres, is from the account of such cases as the following. Prof. Ball, of Paris, records the instance of a young man who one morning heard himself addressed by name, and yet he could not see his interlocutor. He replied, however, and a conversation followed, in the course of which his ghostly visitant informed him that his name was M. Gabbage.

After this occurrence he frequently heard M. Gabbage speaking to him. Unfortunately M. Gabbage was always recommending him to perform very outrageous acts, such as to give an overdose of chlorodyne to a friend's child, and to jump out of a second-floor window. This led to the patient being kept under observation, and it was found that he was suffering from a one-sided hallucination.

Similar cases have been recorded in which disease of one sensory perceptive area has produced unilateral hallucination.

I cannot see that these cases in any way support the notion of the duality of the mind. On the contrary, they go to show that while as a rule the sensory perceptive areas are simultaneously engaged upon one object, it is still possible for one only to be stimulated, and for the mind to conclude that the information it receives in this unusual way must be supernatural, and at any rate proceeding from one side of the body.

To conclude, I have endeavoured to show that as a rule both cerebral hemispheres are engaged at once in the receiving and considering one idea. That under no circumstances can two ideas either be considered or acted upon attentively at the same moment. That therefore the brain is a single instrument.

It now appears to me that one is justified in suggesting that our ideas of our being single individuals is due entirely to this single action of the brain.

Laycock showed that the Ego was the sum of our experience, and every writer since confirms him. But our experience means (1) our perception of ideas transmitted and elaborated by the sensory paths of the brain; and (2) our consciousness of the acts we perform. If now these things are always single, the idea of the Ego surely must also be single.

THE FRENCH ASSOCIATION

THE fourteenth meeting of this Association has been held this year in Grenoble, one of the most intelligent and active French provincial cities, although it has not quite 25,000 inhabitants. It is situated on the banks of the Isère, one of the principal affluents of the Rhone, and is the head city of the Isère department.

The presidential address was delivered by M. Verneuil in the municipal gymnasium in the very hall where girls and boys are daily using horizontal and vertical bars. The actual President, M. Verneuil, is a surgeon in large practice, who delivered a long address on his profession under the title of "Confessions of a Surgeon of the Nineteenth Century." After having tried with much wit and force of expression to dispell prejudices current against practitioners, he went so far as to argue that operations are less frequent in France than in other lands, in spite of animal vivisection being free.

M. Napias, the general secretary, read a long paper on the scientific men who have died during the year, which has been singularly fatal to French science, and he announced the creation of a section of public hygiene and medicine. This section was inaugurated by an address of M. Chauveau, the Director of the Lyons Veterinary School, on the choleraic vaccination by Ferran. Not having been able to witness the operations conducted by Dr. Ferran, the referee was not in a position to give a definite opinion on this all-important matter; but he is satisfied that Dr. Ferran has adhered faithfully to the principles established by M. Pasteur. Although he may be assailed as lacking correct information on the biological part of the question, none of his assumptions can be considered as being in contradiction with well-stated and observed facts. It is probable that his method may be rendered les cumbrous and painful for the patients, but credit must be given to him for his daring experiments.

M. Galande, the treasurer, showed that the Association is possessed now of 20,000*l.*, invested in public funds. The amount of the annual subscriptions is 2250*l.*, so it leaves a large surplus for the publishing of the transactions and encouragement given to science.

It was announced that the present meeting should have to vote on the fusion with the Association Française, which was created by Leverrier, and presided over by Milne-Edwards since the great astronomer died. No successor will be given to Milne-Edwards, as the two scientific bodies will unite.

The public lectures at the Sorbonne will continue, and a scientific paper will be started, issuing in fortnightly numbers.

M. Rey, the Maire of Grenoble, delivered a complimentary speech to the members of the Association, reminding them that Grenoble was the site of the first Marcel Deprez experiments after their short inauguration at Munich. The results of these important experiments now continuing between Creil and Paris are satisfactory.

In the section of anthropology M. de Mortillet discussed the question of Tertiary man. He said the question was not to know if man as he exists at the present day already existed in the Tertiary epoch. Animals certainly varied from one geological stratum to another, and these variations increased as the strata were geologically distant. The higher the animals the greater the variation. It was to be inferred then that man would vary more rapidly than the other mammals. The problem was not to discover existing man in the Tertiary period, but only to find there an ancestral form of man a predecessor of the man of historical times. The question was, Do there exist in the Tertiary strata objects which imply the existence of an intelligent being? M. de Mortillet has no hesitation in saying there do. These objects have, in fact, been found at two different stages of the Tertiary epoch—in the Lower Tertiary at Thenay, and in the Upper Tertiary, at Otta; in Portugal, and at Puy Courny, in Cantal. These objects proved that at these two epochs there existed in Europe animals acquainted with the use of fire, and able more or less to cut stone. During the Tertiary period there existed, then, animals less intelligent than existing man, but much more intelligent than existing apes. This animal, to which M. de Mortillet gives the name of *anthropéthique*, or ape man, was, he maintains, an ancestral form of historic man, whose skeleton has not yet been discovered, but who has made himself known to us in the clearest manner by his works. A number of flints were exhibited from the strata in question, which had been intentionally chipped and exposed to fire. After a long discussion, the almost unanimous opinion was expressed "that after this meeting and discussion at Grenoble there can no longer be a doubt of the existence in the Tertiary period of an ancestral form of man!"

The sitting of the Sections took place in the Palace of the University (Faculties).

NORTH AMERICAN MUSEUMS

A REPORT has just been issued on a visit to the Museums of America and Canada, by V. Ball, M.A., F.R.S., Director of the Science and Art Museum, Dublin. Prof. Ball visited a large number of institutions in various parts of North America, and in his introduction says that he was impressed especially with the system, thoroughness, and good order which appeared to pervade the arrangements in the majority of these institutions. Many of them are of late growth, but already possess an astonishing degree of vigour, while their supporters and officers look forward in a spirit of great hopefulness to what must be described as gigantic extensions of their spheres of usefulness in the future. Largely dependent for their existence on the liberality of private individuals, they take what aid they can get from the Government, and it amounts, in the majority of cases, merely to State recognition. Those of them which possess directly educational functions claim an abundant harvest of good results, and there can be no doubt that the facilities which now exist for instruction in science and art are largely availed of in the principal cities of America.

Mr. Ball did not happen to come across, if such institutions exist, any which were in a condition of decadence from the apathy and indifference of those for whose benefit they had been established. On the contrary, several are unable, owing to their means or room being limited, to receive all the pupils who present themselves.

"That an interest in museums is largely felt in America is not only evidenced by the number of them which are scientifically conducted and the large number of persons who visit them, but it is also proved by the existence of commercially-conducted