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BODY AND MIND

WITH OTHER ESSAYS

BY

WILLIAM KINGDON CLIFFORD

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WITH OTHER ESSAYS.

BY

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CONTENTS.

BODY AND MIND.

THE subject of this Lecture is one in regard to which a great change has recently taken place in the public mind. Some time ago it was the custom to look with suspicion upon all questions of a metaphysical nature as being questions that could not be discussed with any good result, and which, leading inquirers round and round in the same circle, never came to an end. But quite of late years there is an indication that a large number of people are waking up to the fact that Science has something to say upon these subjects; and the English people have always been very ready to hear what Science can say—understanding by Science what we shall now understand by it, that is, organized common sense.

When I say Science, I do not mean what some people are pleased to call Philosophy. The word "philosopher," which meant originally "lover of wisdom," has come, in some strange way, to mean a man who thinks it his business to explain everything in a certain number of large books. It will be found, I think, that in proportion to his colossal ignorance is the perfection and symmetry of the system which he sets up; because it is so much easier to put an empty room tidy than a full one. A man of science, on the other hand, explains as much as ever he can, and then he says, "This is all I can do; for the rest you must ask the next man." And with regard to such explanations as he has given, whether the next man comes at all, whether there is any next man or any further explanation or not (and we may have to wait hundreds. or even thousands of years before another step is made), yet, if the original step was a scientific step, was made by true scientific methods, and was an organization of the normal experience of healthy men, that step will remain good for ever, no matter how much is left unexplained by it.

Now, the supposition that this subject, in itself, is necessarily one which cannot be discussed to good purpose, that is to say, in such a way as to lead to definite results, is a mistake. The fact that the subject has been discussed for many hundreds of years to no good purpose, and without leading to definite results, by great numbers of

people, is due to the method which was employed, and not to the subject itself; and, in fact, if we like to look in the same way upon other subjects as we have been accustomed to look upon metaphysics —if we regard every man who has written about mathematics or mechanics as having just the same right to speak and to be heard that we give to every man who has written about metaphysics—then, I think, we shall find that exactly the same thing can be said about the most certain regions of human science.

Those who like to read the last number of the *Edinburgh Review*,[1] for example, will find from an article on "Comets and Meteors," that it is at present quite an open question whether bodies which are shot out from the sun by eruptive force may not come to circle about the sun in orbits which are like those of the planets. Now, that is not an open question; the supposition is an utterly absurd one, and has been utterly absurd from the time of Kepler. Again, those who are curious enough to read a number of pamphlets that are to be found here and there, may think it is an open question whether the ratio of the circumference of a circle to its diameter may not be expressed by certain finite numbers. It is not an open question to Science; it is only open to those people who do not know any Trigonometry, and who will not learn it. In exactly the same way there are numbers of questions relating to the connection of the mind with the body which have ceased to be open questions, because Science has had her word to say about them; and they are only open now to people who do not know what that word of Science is, and who will not try to learn it.

The whole field of human knowledge may be divided roughly, for the sake of convenience, into three great regions. There are, first of all, what we call, *par excellence*, the Physical Sciences—those which deal with inanimate matter. Next, there are those sciences which deal with organic bodies—the bodies of living things, whether plants or animals, and the rules according to which those things move. And, lastly, there are those sciences which make a further supposition—which suppose that beside this physical world, including both organic and inorganic bodies, there are also certain other facts, namely, that other men beside me, and most likely other animals beside men, are *conscious*. The sciences which make that supposition are the sciences of Ethics and Politics, which are still in the practical stage, and especially the more advanced science which is now to be considered—Psychology, the Science of Mind itself; that is to say, the science of the laws which regulate the succession of feelings in any one consciousness. Each of these three great divisions began in a form of a number of perfectly disconnected subjects, between which nobody knew of any relation; but in the history of science each of them has been woven together, in consequence of connections being found

[1] October, 1874.

between the different subjects included in it, into a complete whole; and the further progress of the history of science requires that each of these three great threads, into which all the little threads have been twined, should themselves be twined together into a single string.

With regard to the first two groups—the group of mechanical sciences, as we may call them, or the physics of inorganic bodies, and the group of biological sciences, or the physics of organic bodies—the gulf between these two has in these last days been firmly bridged over. A description of that bridge, and an account of the doctrines which form it, will be found in Professor Huxley's admirable lecture delivered at Belfast before the British Association. That bridge, as we have it now, is, in the conception of it, mainly due to Descartes; but parts of it have been worked out since his time by a vast number of physiologists, with the expenditure of an enormous amount of labor and thought. Such facts as that discovered by Harvey, that the movement of the blood was a mere question of hydrodynamics, and was to be explained upon the same principles as the motion of water in pipes—facts like these have been piled up, one upon another, and have gradually led to the conclusion that the science of organic bodies is only a complication of the science of inorganic bodies.

It would not be advisable here to describe in detail the stones which compose this bridge; but we have to ask whether it is possible to construct some similar bridge between the now united Science of Physics, which deals with all phenomena, whether organic or inorganic, in fact with all the material world, and the other science, the Science of Consciousness, which deals with the Laws of Mind and with the subject of Ethics. This is the question which we have now to discuss.

In order to make this bridge a firm one, so that it will not break down like those which philosophers have made, it is necessary to observe with great care what is the exact difference between the two classes of facts. If we confuse the two things together to begin with, if we do not recognize the great difference between them, we shall not be likely to find any explanation which will reduce them to some common term. The first thing, therefore, that we have to do is to realize as clearly as possible how profound the gulf is between the facts which we call physical facts and the facts which we call mental facts. The difference is one which has been observed from primeval times, when man or his pre-human ancestor found it not good to be alone; for the very earliest precept that we find set forth in all societies to regulate the lives of those who belong to them is, "Put yourself in his place"—that is to say, ascribe to other men a consciousness which is like your own. And this belief, which the lowest savage got, that there was something else than the physical organization in

other men, is the foundation of Natural Ethics as well as of the modern Science of Consciousness. But in very early times an hypothesis was formed which was supposed to make this belief easier. If you eat too much you will dream when you are asleep; if you eat too little you will dream when you are awake, or have visions; and those dreams of savages whose food was very precarious led them to a biological hypothesis. They saw in those dreams their fellows, other men, when it appeared from evidence furnished to them afterward that those other men were not there when they were dreaming. Consequently they supposed that the actions of the organic body were caused by some other body which was not physical in the ordinary sense, which was not made of ordinary matter, and this other body was called the Soul. Animism, as Mr. Tylor calls this belief, was at first, then, an hypothesis in the domain of biology. It was a physical hypothesis to account for the peculiar way in which living things went about. But then when people had got this belief in another body which was not a physical body, after a long series of years they reasoned in this way: It is very difficult indeed to suppose that the ordinary matter which makes a man's body can be conscious. This Me is quite different from the flesh and blood which make up a man; but, then, as to this other body, or soul, we do not know anything about it, so that it may as well be conscious as not. That hypothesis put upon the soul, whose basis was in the phenomena of dreams, the explanation of the consciousness which we cannot help believing to exist in other men. I have mentioned this early hypothesis on the subject, because out of it grew the almost universal custom of holding at this time of the year the Festival of the Dead, which we preserve in our All Souls' Day.

But now let us see what it is that Science can tell us and what we can believe in place of that early hypothesis of our savage ancestors. In the first place, let us consider a little more narrowly what we mean by the body, and more especially what we mean by the nervous system; for it is the great discovery of Descartes that the nervous system is that part of the body which is related directly to the mind. This can hardly be better expressed than it is by the first of that series of propositions which Professor Huxley has stated in his lecture.

I. "*The brain is the organ of sensation, thought and emotion; that is to say, some change in the condition of the matter of this organ is the invariable antecedent of the state of consciousness to which each of these terms is applied.*" We may complete this statement by saying not only that some change in the matter of this organ is the invariable antecedent, but that some other change is the invariable concomitant of sensation, thought, and emotion; and that is rather an important remark, as you will see presently.

Let us now look at the general structure of the brain and see what

it is like. We can easily make a rough picture of it, which will serve our present purpose.[1] A parachute is a round piece of paper, like the top of a parasol, with strings going from its circumference to a cork. Let us imagine a parachute with two corks, a red and a blue one, each of these corks being attached by strings, not only to the circumference of our piece of paper, but to innumerable points in the inside of it. Moreover, let innumerable other strings go across from point to point of the paper, like a spider's web spun in the inside of the parasol. And the corks themselves must be tied to each other and to a third cork, say a white one, while from all three streamers fly away in all directions.

This is our diagram. Now the sheet of paper represents the *cerebral hemispheres*, a great sheet of gray nervous matter which forms the outside of your brain, and lies just under your skull. Our red and blue corks are two other masses of gray matter lying at the base of the brain, and called the *optic thalami* and the *corpora striata* respectively. The white cork is another mass of gray matter called the *medulla oblongata*, which is the top of the spinal chord. Our strings which tie part of the parachute together, and our streamers which go out in all directions from the corks, represent the nerves, white threads that run all over the body. And they are of two kinds —there are some which go to the brain from any part of the body, and others which come from the brain to it. As regards the position of the nerves, this is the same thing for both of them, but it is not the same thing with regard to what they do. The nerves which are called Sensory nerves, and which go to the brain, are those which are excited whenever any part of the body is touched. When your finger is touched, a certain excitement is given to the nerves which end in your finger, and that excitement is carried along your arm and away up to the medulla, represented by our white cork. But when you are going to move your arm, the excitement starts from the brain, and goes along the other set of nerves, which are called Motor nerves, or moving nerves, and goes to the muscles which work the part of the arm which you want to move. And that excitement of the nerves by purely mechanical means makes those muscles contract so as to move the part which you want to move. We have, then, a connection between the brain and any part of the body which is of a double kind —there is the means of sending a message to the brain from this part of the body, and the means of taking a message from the brain to this part. The nerves which carry the message to the brain are called the "Sensory nerves," because they accompany what we call sensation; the nerves which carry the message from the brain are called "Motor nerves," because they are the agents in the motion of that part of the body.

[1] See the diagram on p. 12.

All this is expressed in Professor Huxley's second and third propositions.

II. "*The movements of animals are due to the change of form of the muscles, which shorten and become thicker; and this change of form in a muscle arises from a motion of the substance contained within the nerves which go to the muscle.*"

III. "*The sensations of animals are due to a motion of the substance of the nerves which connect the sensory organs with the brain.*"

I pass on to his fourth proposition :—

IV. "*The motion of the matter of a sensory nerve may be transmitted through the brain to motor nerves, and thereby give rise to a contraction of the muscles to which these motor nerves are distributed; and this reflection of motion from a sensory into a motor nerve may take place without volition, or even contrary to it.*"

Let us take that organ of sense which always occurs to us as a type of the others, because it is the most perfect—the eye. The optic nerve, which runs from the eye toward the brain may be represented by one of our streamers going to the red cork, to which it is fastened by a knot that is called the "Optic ganglion." Supposing that you move your hand rapidly toward anybody's eye, a message with news of this movement goes along the nerve to the optic ganglion, and it comes away back again by another streamer, not direct from the ganglion, but from a point on the blue cork very near it, to the muscles which move the eyelid, and that makes the eye wink. You know that the winking of the eye, when anybody moves his hand very rapidly toward it, is not a thing which you determine to do, and which you consider about; it is a thing which happens without your interference with it; and in fact it is not you who wink your eye, but your body that does it. This is called automatic or involuntary motion, or again it is called reflex action, because it is a purely mechanical thing. A wave runs along that nerve, and comes back on another nerve, and that without any deliberation; and at the point where it stops and comes back it is just a reflection like the wave which you send along a string, and which comes back from the end of the string, or like a wave of water which is sent up against a sea-wall, and which reflects itself back along the sea.

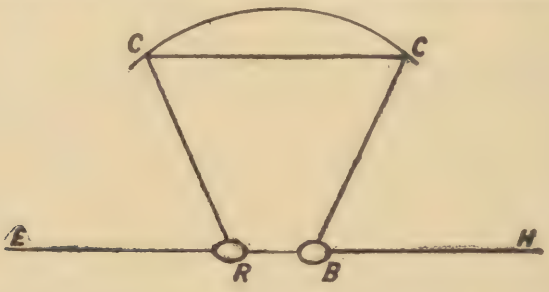
V. "*The motion of any given portion of the matter of the brain, excited by the motion of a sensory nerve, leaves behind it a readiness to be moved in the same way in that part, and anything which resuscitates the motion gives rise to the appropriate feeling. This is the physical mechanism of memory.*" We can, perhaps, make this a little more clear in the following manner: Suppose two messages are sent at once to the brain; each of them is reflected back, but the two disturbances which they set up in the brain create, in some way or other, a link between them, so that when one of these disturbances is set up afterward the other one is

also set up. It is as if every time two bells of a house were rung together, that of itself made a string to tie them together, so that when you rang one bell it was necessary to ring the other bell in consequence. That, remember, is purely a physical circumstance of which we know that it happens. There is a physical excitation or disturbance which is sent along two different nerves, and which produces two different disturbances in the brain, and the effect of these two disturbances taking place together is to make a change in the character of the brain itself, so that when the one of them takes place it produces the other.

Now, there are two different ways in which a stimulus coming to the eye can be made to move the hand. In the first place, suppose you are copying out of a book ; you have the book before you, and you read the book while you are copying with your hand, and consequently the light coming into your eye from the book directs your hand to move in a certain way. It is possible for this light impinging upon the eye to send a message along the optic nerve into the ganglion, and that message may go almost, though not quite, direct to the hand, so as to make the hand move, and that causes the hand to describe the letter which you have seen in the book ; or else the message may go by a longer route which takes more time. A simple experiment to distinguish between these processes was tried by Donders, the great Dutch physiologist. He made a sign to a man at a distance, and when he made this sign the man was to put down a key with his hand. He measured the time which was taken in this process, that is to say, the time which was taken by the message in going from the eye to the ganglion, and then to the hand. Measurements of the rate of nerve-motions have also been made by Helmholtz. The velocity varies to a certain extent in different people, but it is something like one hundred feet a second. But Donders also made another measurement. Suppose it is not decided beforehand whether the man is to move the key with his right or left hand, and this is to be determined by the nature of the signal, then before he can move his hand he has to decide which hand he will use. The time taken for that process of decision was also measured. That process of decision, when looked at from the physical side, means this. The message goes up from the eye to the ganglion. It is immediately connected there with a mass of gray matter represented by our red cork. From that mass of gray matter there go white threads away to the whole of the surface of the cerebral hemispheres, or the paper of our parachute, and they take that message, therefore, which comes from the eye to the ganglion away to all this gray matter which is put round the inside of your skull. There are also white threads which connect all the parts of this gray matter together, and they run across from every part of it to almost every other part of it. As soon as a message has been taken

to this gray matter, there is a vast interchange of messages going on between those parts ; but finally, as the result of that, a number of messages come upon other white threads to another piece of gray matter, which is represented by our blue cork ; from that the message is then taken to the muscles of the hand. There are then two different ways in which a message may go from the eye to the hand. It may go to the optic ganglion, and then almost straight to the hand, and in that case you do not know much about it—you only know that something has taken place, you do not think that you have done it yourself ; or it may go to the optic ganglion, and be sent up to the cerebral hemispheres, and then be sent back to the sensory tract and then on to the hand. But that takes more time, and it implies that you have deliberated upon the act.

The diagram here drawn may make this point more clear. Here E is the eye, R and B are the red and blue corks, and H is the hand.



The curve C C represents the cerebral hemispheres, or the top of our parachute. If the action is so habitually associated with the signal that it takes place involuntarily, without any effort of the will, the message goes from the eye to the hand along the line E R B H. This may happen with a practiced performer when it is settled beforehand which hand he is to use. But if it is necessary to deliberate about the action, to call in the exercise of the will, the message goes round the loop-line, E R C C B H ; from the eye to the optic thalami, from them to the cerebrum, thence to the corpora striata, and so through the medulla to the hand.

Besides this fact which we have just explained, the fact of a message going from one part of the body to the brain and coming out in the motion of some other part of the body, there is another thing which is going on continually, and that is this :—There is a faint reproduction of some excitement which has previously existed in the cerebral hemispheres, and which calls up, by the process which we have just now described, all those that have become associated with it ; and it is continually sending down faint messages which do not actually tell the muscles to move, but which, as it were, begin to tell them to move. They are not always strong enough to produce actual

motions, but they produce just the beginnings of those motions; and that process goes on even when there is apparently no sensation and no motion. If a man is in a brown study, with his eyes shut, although he apparently sees and feels nothing at all, there is a certain action going on inside his brain which is not sensation, but is like it, because it is the transmission to the cerebral hemispheres of faint messages which are copies of previous sensations; and it does not produce motion, but it produces something like it; it produces incipient motion, the beginnings of motion which do not actually take effect. Sometimes a train of thought may so increase in strength as to produce motion. A man may get so excited by a train of thought that he jumps up and does something in consequence. And the sensory impressions which are taken from the ganglia to the hemispheres may be so strong as to produce an illusion; he may think that he sees something, he may think that he sees a ghost, when he does not. This continuous action of the brain depends upon the presence of blood; so long as the proper amount of blood is sent to the brain it is active, and when the blood is taken away it becomes inactive. And it is a curious property of the nervous system that it can direct the supply of blood which is to be sent to a particular part of it. It is possible, by directing your attention to a particular part of your hand, to make a determination of blood to that part which shall in time become a sore place. Some people have given this explanation, which seems a very probable one, of what has happened to those saints who have meditated so long upon the crucifixion that they have got what are called *stigmata*, that is, marks of wounds corresponding to the wounds they were thinking about.

That, then, is the general character of the nervous system which we have to consider in connection with the mind. There is a train of facts between stimulus and motion which may be of two kinds; it may be direct or it may be indirect, it may go round the loop-line or not; and also, there is a continuous action of the brain even when these steps are not taking place in completeness. Moreover, when two actions take place simultaneously, they form a sort of link between them, so that if one of them is afterwards repeated the other gets repeated with it. That is what we have to remember chiefly as to the character of the brain.

Now, let us consider the other class of facts and the connections between them—the facts of consciousness. An eminent divine once said to me that he thought there were only two kinds of consciousness—to have a feeling, and to know that you have a feeling. It seems to me that there is only one kind of consciousness, and that is to have fifty thousand feelings at once, and to know them all in different degrees. Whenever I try to analyze any particular state of consciousness in which I am, I find that it is an extremely complex one. I

cannot help at this moment having a consciousness of all the different parts of this hall, and of a great sea of faces before me ; and I cannot help having the consciousness, at the same time, of all the suggestions that that picture makes, that each face represents a person sitting there and listening or not, as the case may be. And I cannot help combining with them at the same moment a number of actions which they suggest to me, and in particular the action of going on speaking. There are a great number of elements of complexity which I cannot describe, because I am so faintly conscious of them that I cannot remember them. Any state of our consciousness, then, as we are at present constituted, is an exceedingly complex thing ; but it certainly possesses this property, that if two feelings have occurred together, and one of them afterward occurs again, it is very likely that the other will be called up by it. That is to say, two states of consciousness which have taken place at the same moment produce a link between them, so that a repetition of the one calls up a repetition of the other.

Again, I find a certain train of facts between my sensations and my exertions. When I see a thing, I may go through a long process of deliberation as to what I shall do with it, and then afterward I may do that which I have deliberated and decided upon. But, on the other hand, I may, by seeing a thing, be quite suddenly forced into doing something without any chance of deliberation at all. If I suddenly see a cab coming upon me from the corner of a street where I did not at all expect it, I jump out of the way without thinking that it is a very desirable thing to get out of the way of the cab. But, if I see a cab a little while before, and have more time to think about it, then it occurs to me that it will be unpleasant and undesirable to be run over by that cab, and that I can avoid it by walking out of the way. You here see that there are in the case of the mind two distinct trains of facts between sensation and exertion. There is an involuntary train of facts when the exertion follows the sensation without asking my leave, and there is a voluntary train in which it does ask my leave.

Then, again, there is this fact : that even when there is no actual sensation and no actual exertion, there may still be a long train of facts and sensations which hang together ; there may be faint reproductions of sensation which are not so vivid as are the sensations themselves, but which form a series of pictures of sensations which pass continually before my mind ; and there will be faint beginnings of action. Now the sense in which those are faint beginnings of action is very instructive. Any beginning of an action is what we call a judgment. When you see a thing, you in the first instance form no judgment about it at all—you are not prepared to assert any proposition—you merely have the feeling of a certain sight or sound presented to you ; but after a very short space of time, so short that you cannot perceive it, you begin to frame propositions. If you consider

what a proposition means, you will see it must correspond to the beginning of some sort of exertion. When you say that A is B, you mean that you are going to act as if A were B. If I see water with a particularly dull surface, and with stones resting upon the surface of it, then, first of all, I have merely an impression of a certain sheet of color, and of certain objects which interrupt the color of that sheet. But the second thing that I do is come to the conclusion that the water is frozen, and that, therefore, I may walk upon it. The assertion that the water is frozen implies a bundle of resolves; which means, given certain other conditions, I shall go and walk upon it. So, then, an act of judgment or an assertion of any kind implies a certain incipient action of the muscles, not actually carried out at that time and place, but preparing a certain condition of the mind such as afterward, when the occasion comes, will guide the action that we shall take up.

Now, then, what is it that we mean by the *character* of a person? You judge of a person's character by what he thinks and does under certain circumstances. Let us see what determines this. We can only be speaking here of voluntary actions—those actions in which the person is consulted, and which are not done by his body without his leave. In those voluntary actions what takes place is that a certain sensation is communicated to the mind, the sensation is manipulated by the mind, and conclusions are drawn from it, and then a message is sent out which causes certain motions to take place. The character of the person is evidently determined by the nature of this manipulation. If the sensation suggests a wrong thing, the character of the person will be bad; if the sensation suggests in the great majority of cases a right thing, you will say that the character of the person is good. So, then, it is the character of the mind which determines what it will do with a given sensation, and what act will follow from it—which determines what we call the personality of any person; and that character is persistent in the main, although it is continually changing a little. The vast mass of it is a thing which lasts through the whole of every individual's life, although everything which happens to him makes some small change in it, and that constitutes the education of the man.

Then the question arises, Is there anything else in your consciousness of a different nature from what we have here described? That is a question which every man has to decide by examining his own consciousness. I do not find anything else in mine. If you find anything else in yours, it is extremely important that you should analyze it and find out all that you possibly can about it, and state it in the clearest form to other people; because it is one of the most important problems of philosophy to account for the whole of consciousness out of individual feelings. It seems to me that the

account of which I have only given a very rough sketch, which was begun by Locke and Hume, and has been carried out by their successors, chiefly in this country, is in its great general features complete, and leaves nothing but more detailed explanations to be desired. It seems to me that I find nothing in myself which is not accounted for when I describe myself as a stream of feelings such that each of them is capable of a faint repetition, and that when two of them have occurred together the repetition of the one calls up the other, and that there are rules according to which the resuscitated feeling calls up its fellows. These are, in the main, fixed rules which determine and are determined by my character; but my character is gradually changing in consequence of the education of life. It seems to me that this is a complete account of all the kinds of facts which I can find in myself; and, as I said before, if anybody finds any other kinds of facts in himself, it is an exceedingly important thing that he should describe them as clearly as he possibly can.

We have described two classes of facts; let us now notice the parallelism between them. First, we have these two parallel facts, that two actions of the brain which occur together, form a link between themselves, so that the one being called up the other is called up; and two states of consciousness which occur together form a link between them, so that when one is called up the other is called up. But also we find a train of facts between the physical fact of the stimulus of light going into the eye and the physical fact of the motion of the muscles. Corresponding to a part of that train, we have found a train of facts between sensation, the mental fact which corresponds to a message arriving from the eye, and exertion, the mental fact which corresponds to the motion of the hand by a message going out along the nerves. And we have found a correspondence between the continuous action of the brain and the continuous existence of consciousness apparently independent of sensation and exertion.

But let us look at this correspondence a little more closely, we shall find that there are one or two things which can be established with practical certainty. In the first place, it is not the whole of the physical train of facts which corresponds to the mental train of facts. The beginning of the physical train consists of light going into the eye and exciting the retina, and then of that wave of excitation being carried along the optic nerve to the ganglion. For all we know, and it is a very probable thing, the mental fact begins here, at the ganglion. There is no sensation till the message has got to the optic ganglion, for this reason, that if you press the optic nerve behind the eye you can produce the sensation of light. It is like tapping a telegraph, and sending a message which has not come from the station from which it ought to have come; nobody at the other end can tell

whether it has come from that station or not. The optic ganglion cannot tell whether this message which comes along the nerve has come from the eye or is the result of a tapping of the telegraph, whether it is produced by light or by pressure upon the nerve. It is a fact of immense importance that all these nerves are exactly of the same kind. The only thing which the nerve does is to transmit a message which has been given to it; it does not transmit a message in any other way than the telegraph wire transmits a message—that is to say, it is excited at certain intervals, and the succession of these intervals determines what this message is, not the nature of the excitation which passes along the wire. So that if we watched the nerve excited by pressure, the message going along to the ganglion would be exactly the same as if it were the actual sight of the eye. We may draw from this the conclusion that the mental fact does not begin anywhere before the optic ganglion. Again, a man who has had one of his legs cut off can try to move his toes, which he feels as if they were still there; and that shows that the consciousness of the motor impulse which is sent out along the nerve does not go to the end to see whether it is obeyed or not. The only way in which we know whether our orders, given to any parts of our body, are obeyed, is by having a message sent back to say that they are obeyed. If I tell my hand to press against this black-board, the only way in which I know that it does press is by having a message sent back by my skin to say that it is pressed. But supposing there is no skin there, I can have the exertion that precedes the action without actually performing it, because I can send out a message, and consciousness stops with the sending of the message, and does not know anything further. So that the mental fact is somewhere or other in the region R C C B of the diagram, and does not include the two ends. That is to say, it is not the whole of the bodily fact that the mental fact corresponds to, but only an intermediate part of it. If it just passes through the points R B, without going round the loop from C to C, then we merely have the sensation that something has taken place—we have had no voice in the nature of it and no choice about it. If it has gone round from C to C, we have a much larger fact—we have that fact which we call choice, or the exercise of volition. We may conclude, then—I am not able in so short a space as I have to give you the whole evidence which goes to an assertion of this kind; but there is evidence which is sufficient to satisfy any competent scientific man of this day—that every fact of consciousness is parallel to some disturbance of nerve matter, although there are some nervous disturbances which have no parallel in consciousness, properly so called; that is to say, disturbances of my nerves may exist which have no parallel in my consciousness.

We have now observed two classes of facts and the parallelism

between them. Let us next observe what an enormous gulf there is between these two classes of facts.

The state of a man's brain and the actions which go along with it are things which every other man can perceive, observe, measure, and tabulate; but the state of a man's own consciousness is known to him only, and not to any other person. Things which appear to us and which we can observe are called *objects* or *phenomena*. Facts in a man's consciousness are not objects or phenomena to any other man; they are capable of being observed only by him. We have no possible ground, therefore, for speaking of another man's consciousness as in any sense a part of the physical world of objects or phenomena. It is a thing entirely separate from it; and all the evidence that we have goes to show that the physical world gets along entirely by itself, according to practically universal rules. That is to say, the laws which hold good in the physical world hold good everywhere in it—they hold good with practical universality, and there is no reason to suppose anything else but those laws in order to account for any physical fact; there is no reason to suppose anything but the universal laws of mechanics in order to account for the motion of organic bodies. The train of physical facts between the stimulus sent into the eye, or to any one of our senses, and the exertion which follows it, and the train of physical facts which goes on in the brain, even when there is no stimulus and no exertion—these are perfectly complete physical trains, and every step is fully accounted for by mechanical conditions. In order to show what is meant by that, I will endeavor to explain another supposition which might be made. When a stimulus comes into the eye there is a certain amount of energy transferred from the ether, which fills space, to this nerve; and this energy travels along into the ganglion, and sets the ganglion into a state of disturbance which may use up some energy previously stored in it. The amount of energy is the same as before by the law of the conservation of energy. That energy is spread over a number of threads which go out to the brain, and it comes back again and is reflected from there. It may be supposed that a very small portion of energy is created in that process, and that while the stimulus is going round this loop-line it gets a little push somewhere, and then, when it comes back to the ganglia, it goes away to the muscle and sets loose a store of energy in the muscle so that it moves the limb. Now the question is, Is there any creation of energy anywhere? Is there any part of the physical progress which cannot be included within ordinary physical laws? It has been supposed, I say, by some people, as it seems to me merely by a confusion of ideas, that there is, at some part or other of this process, a creation of energy; but there is no reason whatever why we should suppose this. The difficulty in proving a negative in these cases is similar to that in

proving a negative about anything which exists on the other side of the moon. It is quite true that I am not absolutely certain that the law of the conservation of energy is exactly true; but there is no more reason why I should suppose a particular exception to occur in the brain than anywhere else. I might just as well assert that whenever anything passes over the Line, when it goes from the north side of the Equator to the south, there is a certain creation of energy, as that there is a creation of energy in the brain. If I chose to say that the amount was so small that none of our present measurements could appreciate it, it would be difficult, or indeed impossible for anybody to disprove that assertion; but I should have no reason whatever for making it. There being, then, an absence of positive evidence that the conditions are exceptional, the reasons which lead us to assert that there is no loss of energy in organic any more than in inorganic bodies are absolutely overwhelming. There is no more reason to assert that there is a creation of energy in any part of an organic body, because we are not absolutely sure of the exact nature of the law, than there is reason, because we do not know what there is on the other side of the moon, to assert that there is a sky-blue peacock there with forty-five eyes in his tail.

Therefore it is not a right thing to say, for example, that the mind is a force, because if the mind were a force we should be able to perceive it. I should be able to perceive your mind and to measure it, but I cannot; I have absolutely no means of perceiving your mind. I judge by analogy that it exists, and the instinct which leads me to come to that conclusion is the social instinct, as it has been formed in me by generations during which men have lived together; and they could not have lived together unless they had gone upon that supposition. But I may very well say that among the physical facts which go along at the same time with mental facts there are forces at work. That is perfectly true, but the two things are on two utterly different platforms—the physical facts go along by themselves, and the mental facts go along by themselves. There is a parallelism between them, but there is no interference of one with the other. Again, if anybody says that the will influences matter, the statement is not untrue, but it is nonsense. The will is not a material thing, it is not a mode of material motion. Such an assertion belongs to the crude materialism of the savage. The only thing which influences matter is the position of surrounding matter, or the motion of surrounding matter. It may be conceived that at the same time with every exercise of volition there is a disturbance of the physical laws; but this disturbance, being perceptible to me, would be a physical fact accompanying the volition, and could not be the volition itself, which is not perceptible to me. Whether there is such a disturbance of the physical laws or not is a question of fact to which

we have the best of reasons for giving a negative answer; but the assertion that another man's volition, a feeling in his consciousness which I cannot perceive, is part of the train of physical facts which I may perceive—this is neither true nor untrue, but nonsense; it is a combination of words whose corresponding ideas will not go together.

Thus we are to regard the body as a physical machine, which goes by itself according to a physical law, that is to say, is automatic. An automaton is a thing which goes by itself when it is wound up, and we go by ourselves when we have had food. Excepting the fact that other men are conscious, there is no reason why we should not regard the human body as merely an exceedingly complicated machine which is wound up by putting food into the mouth. But it is not *merely* a machine, because consciousness goes with it. The mind, then, is to be regarded as a stream of feelings which runs parallel to, and simultaneous with, a certain part of the action of the body, that is to say, that particular part of the action of the brain in which the cerebrum and the sensory tract are excited.

Then, you say, if we are automata what becomes of the freedom of the will? The freedom of the will, according to Kant, is that property which enables us to originate events independently of foreign determining causes; which, it seems to me, amounts to saying precisely that we are automata, that is, that we go by ourselves, and do not want anybody to push or pull us. The distinction between an automaton and a puppet is that the one goes by itself when it is wound up, and the other requires to be pushed or pulled by wires or strings. We do not want any stimulus from without, but we go by ourselves when we have had our food, and therefore so far as that distinction goes we are automata. But we are more than automata, because we are conscious; mental facts go along with the bodily facts. That does not hinder us from describing the bodily facts by themselves, and if we restrict our attention to them we must describe ourselves as automata.

The objection which many people feel to this doctrine is derived, I think, from the conception of such automata as are made by man. In that case there is somebody outside the automaton who has constructed it in a certain definite way, with definite intentions, and has meant it to go in that way; and the whole action of the automaton is determined by that person outside. If we consider, for example, a machine such as Frankenstein made, and imagine ourselves to have been put together as that fearful machine was put together by a German student, the conception naturally strikes us with horror; but if we consider the actual fact, we shall see that our own case is not an analogous one. For, as a matter of fact, we were not made by any Frankenstein, but we made ourselves. I do not mean that every individual has made the whole of his own character, but that

the human race as a whole has made itself during the process of ages. The action of the whole race at any given time determines what the character of the race shall be in the future. From the continual storing-up of the effects of such actions, graven into the character of the race, there arises in process of time that exact human constitution which we now have. By the process of natural selection all the actions of our ancestors are built into us and form our character, and in that sense it may be said that the human race has made itself. In that sense also we are individually responsible for what the human race will be in the future, because every one of our actions goes to determine what the character of the race shall be to-morrow. If, on the contrary, we suppose that in the action of the brain there is some point where physical causes do not apply, and where there is a discontinuity, then it will follow that some of our actions are not dependent upon our character. Provided the action which goes on in my brain is a continuous one, subject to physical rules, then it will depend upon what the character of my brain is ; or if I look at it from the mental side, it will depend upon what my mental character is ; but if there is a certain point where the law of causation does not apply, where my action does not follow by regular physical causes from what I am, then I am not responsible for it, because it is not I that do it. So you see the notion that we are not automata destroys responsibility ; because, if my actions are not determined by my character in accordance with the particular circumstances which occur, then I am not responsible for them, and it is not I that do them.

Moreover, if we once admit that physical causes are not continuous, but that there is some break, then we leave the way open for the doctrine of a destiny or a Providence outside of us, overruling human efforts and guiding history to a foregone conclusion. Now, of course it is the business of the seeker after truth to find out whether a proposition is true or not, and not what are the moral consequences which may be expected to follow from it. But I do think that if it is right to call any doctrine immoral, it is right so to call this doctrine, when we remember how often it has paralyzed the efforts of those who were climbing honestly up the hillside toward the light and the right, and how often it has nerved the sacrilegious arm of the fanatic or the adventurer who was conspiring against society.

I want now, very briefly indeed, to consider to what extent these doctrines furnish a bridge between the two classes of facts. I have said that the series of mental facts corresponds to only a portion of the action of the organism. But we have to consider not only ourselves, but also those animals which are next below us in the scale of organization, and we cannot help ascribing to them a consciousness which is analogous to our own. We find, when we attempt to enter

into that, and to judge by their actions what sort of consciousness they possess, that it differs from our own in precisely the same way that their brains differ from our brains. There is less of the co-ordination which is implied by a message going round the loop-line. A much larger number of the messages which go in at a cat's eyes and come out at her paws go straight through without any loop-line at all than do so in the case of a man; but still there is a little loop-line left. And the lower we go down in the scale of organization the less of this loop-line there is; yet we cannot suppose that so enormous a jump from one creature to another should have occurred at any point in the process of evolution as the introduction of a fact entirely different and absolutely separate from the physical fact. It is impossible for anybody to point out the particular place in the line of descent where that event can be supposed to have taken place. The only thing that we can come to, if we accept the doctrine of evolution at all, is, that even in the very lowest organisms, even in the Amœba which swims about in our own blood, there is something or other, inconceivably simple to us, which is of the same nature with our own consciousness, although not of the same complexity—that is to say (for we cannot stop at organic matter, knowing as we do that it must have arisen by continuous physical processes out of inorganic matter), we are obliged to assume, in order to save continuity in our belief, that along with every motion of matter, whether organic or inorganic, there is some fact which corresponds to the mental fact in ourselves. The mental fact in ourselves is an exceedingly complex thing; so also our brain is an exceedingly complex thing. We may assume that the quasi-mental fact which corresponds and which goes along with the motion of every particle of matter is of such inconceivable simplicity, as compared with our own mental fact, with our consciousness, as the motion of a molecule of matter is of inconceivable simplicity when compared with the motion in our brain.

This doctrine is not merely a speculation, but is a result to which all the greatest minds that have studied this question in the right way have gradually been approximating for a long time.

Again, let us consider what takes place when we perceive anything by means of our eye. A certain picture is produced upon the retina of the eye, which is like the picture on the ground-glass plate in a photographic camera; but it is not there that the consciousness begins, as I have shown before. When I see anything, there is a picture produced on the retina, but I am not conscious of it there; and in order that I may be conscious the message must be taken from each point of this picture along the special nerve-fibre to the ganglion. These innumerable fine nerves which come away from the retina go each of them to a particular point of the ganglion, and the result is that, corresponding to that picture at the back of the retina, there is

a disturbance of a great number of centres of gray matter in the ganglion. If certain parts of the retina of my eye, having light thrown upon them, are disturbed so as to produce the figure of a square, then certain little pieces of gray matter in this ganglion, which are distributed we do not know how, will also be disturbed, and the impression corresponding to that is a square. Consciousness belongs to this disturbance of the ganglion, and not to the picture in the eye; and therefore it is something quite different from the thing which is perceived. But at the same time, if we consider another man looking at something, we shall say that the fact is this—there is something outside of him which is matter in motion, and that which corresponds inside of him is also matter in motion. The external motion of matter produces in the optic ganglion something which corresponds to it, but is not like it. Although for every point in the object there is a point of disturbance in the optic ganglion, and for every connection between two points in the object there is a connection between two disturbances, yet they are not like one another. Nevertheless they are made of the same stuff; the object outside and the optic ganglion are both matter, and that matter is made of molecules moving about in ether. When I consider the impression which is produced upon my mind of any fact, that is just a part of my mind; the impression is a part of me. The hall which I see now is just an impression produced on my mind by something outside of it, and that impression is a part of me.

We may conclude from this theory of sensation, which is established by the discoveries of Helmholtz, that the feeling which I have in my mind—the picture of this hall—is something corresponding, point for point, to the actual reality outside. Though every small part of the reality which is outside corresponds to a small part of my picture, though every connection between two parts of that reality outside corresponds to a connection between two parts of my picture, yet the two things are not alike. They correspond to one another, just as a map may be said in a certain sense to correspond with the country of which it is a map, or as a written sentence may be said to correspond to a spoken sentence. But then I may conclude from what I said before that, although the two corresponding things are not alike, yet they are made of the same stuff. Now what is my picture made of? My picture is made of exceedingly simple mental facts, so simple that I only feel them in groups. My picture is made up of these elements; and I am therefore to conclude that the real thing which is outside me, and which corresponds to my picture, is made up of similar things; that is to say, the reality which underlies matter, the reality which we perceive as matter, is that same stuff which, being compounded together in a particular way, produces mind. What I perceive as your brain is really, in itself, your consciousness, is You; but, then, that

which I call your brain, the material fact, is merely my perception. Suppose we put a certain man in the middle of the hall, and we all looked at him. We should all have perceptions of his brain; those would be facts in our consciousness, but they would be all different facts. My perception would be different from the picture produced upon you, and it would be another picture, although it might be very like it. So that corresponding to all those pictures which are produced in our minds from an external object there is a reality which is not like the pictures, but which corresponds to them point for point, and which is made of the same stuff that the pictures are. The actual reality which underlies what we call matter is not the same thing as the mind, is not the same thing as our perception, but it is made of the same stuff. To use the words of the old disputants, we may say that matter is not of the *same* substance as mind, not *homoousion*, but it is of *like* substance, it is made of similar stuff differently compacted together, *homoiousion*.

With the exception of just this last bridge connecting the two great regions of inquiry that we have been discussing, the whole of what I have said is a body of doctrine which is accepted now, as far as I know, by all competent people who have considered the subject. There are, of course, individual exceptions with regard to particular points, such as that I have mentioned about the possible creation of energy in the brain; but these are few, and they occur mainly, I think, among those who are so exceedingly well acquainted with one side of the subject that they regard the whole of it from the point of view of that side, and do not sufficiently weigh what may come from the other side. With such exceptions as those, and with the exception of the last speculation of all, the doctrine which I have expounded to you is the doctrine of Science at the present day.

These results may now be applied to the consideration of certain questions which have always been of great interest. The application which I shall make is a purely tentative one, and must be regarded as merely indicating that such an application becomes more possible every day. The first of these questions is that of the possible existence of consciousness apart from a nervous system, of mind without body. Let us first of all consider the effect upon this question of the doctrines which are admitted by all competent scientific men. All the consciousness that we know of is associated with a brain in a certain definite manner, namely, it is built up out of elements in the same way as part of the action of the brain is built up out of elements; an element of one corresponds to an element in the other; and the mode of connection, the shape of the building, is the same in the two cases. The mere fact that all the consciousness we know of is associated with certain complex forms of matter need only make us exceedingly cautious not to imagine any consciousness apart from matter without

very good reason indeed ; just as the fact of all swans having turned out white up to a certain time made us quite rightly careful about accepting stories that involved black swans. But the fact that mind and brain are associated in a definite way, and in that particular way that I have mentioned, affords a very strong presumption that we have here something which can be *explained ;* that it is possible to find a reason for this exact correspondence. If such a reason can be found, the case is entirely altered ; instead of a provisional probability which may rightly make us cautious, we should have the highest assurance that Science can give, a practical certainty on which we are bound to act, that there is no mind without a brain. Whatever, therefore, is the probability that an explanation exists of the connection of mind with brain in action, such is also the probability that each of them involves the other.

If, however, that particular explanation which I have ventured to offer should turn out to be the true one, the case becomes even stronger. If mind is the reality or substance of that which appears to us as brain-action, the supposition of mind without brain is the supposition of an organized material substance not affecting other substances (for if it did it might be perceived), and therefore not affected by them ; in other words, it is the supposition of immaterial matter, a contradiction in terms to the fundamental assumption of the uniformity of nature, without practically believing in which we should none of us have been here to-day. But if mind without brain is a contradiction, is it not still possible that an organization like the brain can exist without being perceived, without our being able to hold it fast, and weigh it, and cut it up? Now this is a physical question, and we know quite enough about the physical world to say, "Certainly not." It is made of atoms and ether, and there is no room in it for ghosts.

The other question which may be asked is this : Can we regard the universe, or that part of it which immediately surrounds us, as a vast brain, and therefore the reality which underlies it as a conscious mind? This question has been considered by the great naturalist Du Bois Reymond, and has received from him that negative answer which I think we also must give. For we found that the particular organization of the brain which enables its action to run parallel with consciousness amounts to this—that disturbances run along definite channels, and that two disturbances which occur together establish links between the channels along which they run, so that they naturally occur together again. It will, I think, be clear to every one that these are not characteristics of the great interplanetary spaces. Is it not possible, however, that the stars we can see are just atoms in some vast organism, bearing some such relation to it as the atoms which make up our brains bear to us? I am sure I do not know. But

it seems clear that the knowledge of such an organism could not extend to events taking place on the earth, and that its volition could not be concerned in them. And if some vast brain existed far away in space, being invisible because not self-luminous, then, according to the laws of matter at present known to us, it could affect the solar system only by its weight.

On the whole, therefore, we seem entitled to conclude that during such time as we can have evidence of, no intelligence or volition has been concerned in events happening within the range of the Solar system, except that of animals living on the planets. The weight of such probabilities is, of course, estimated differently by different people, and the questions are only just beginning to receive the right sort of attention. But it does seem to me that we may expect in time to have negative evidence on this point of the same kind and of the same cogency as that which forbids us to assume the existence between the Earth and Venus of a planet as large as either of them.

Now, about these conclusions which I have described as probable ones, there are two things that may be said. In the first place, it may be said that they make the world a blank, because they take away the objects of very important and widespread emotions of hope and reverence and love, which are human faculties and require to be exercised, and that they destroy the motives for good conduct. To this it may be answered that we have no right to call the world a blank while it is full of men and women, even though our one friend may be lost to us. And in the regular everyday facts of this common life of men, and in the promise which it holds out for the future, there is room enough and to spare for all the high and noble emotions of which our nature is capable. Moreover, healthy emotions are felt about facts and not about phantoms; and the question is not "What conclusion will be most pleasing or elevating to my feelings?" but "What is the truth?" For it is not all human faculties that have to be exercised, but only the good ones. It is not right to exercise the faculty of feeling terror or of resisting evidence. And if there are any faculties which prevent us from accepting the truth and guiding our conduct by it, these faculties ought not to be exercised. As for the assertion that these conclusions destroy the motive for good conduct, it seems to me that it is not only utterly untrue, but, because of its great influence upon human action, one of the most dangerous doctrines that can be set forth. The two questions which we have last discussed are exceedingly difficult and complex questions: the ideas and the knowledge which we used in their discussion are the product of long centuries of laborious investigation and thought; and perhaps, although we all make our little guesses, there is not one in a million who has any right to a definite opinion about them. But it is not necessary to answer these questions in order to tell an honest

man from a rogue. The distinction of right and wrong grows up in the broad light of day out of natural causes, wherever men live together; and the only right motive to right action is to be found in the social instincts which have been bred into mankind by hundreds of generations of social life. In the target of every true Englishman's allegiance the bull's-eye belongs to his countrymen, who are visible and palpable and who stand around him; not to any far-off, shadowy centre beyond the hills, *ultra montes*, either at Rome or in heaven. Duty to one's countrymen and fellow-citizens, which is the social instinct guided by reason, is in all healthy communities the one thing sacred and supreme. If the course of things is guided by some unseen intelligent person, then this instinct is his highest and clearest voice, and because of it we may call him good. But if the course of things is not so guided, that voice loses nothing of its sacredness, nothing of its clearness, nothing of its obligation.

In the second place, it may be said that Science ought not to deal with these questions at all; that while scientific men are concerned with physical facts, they are *dans leur droit*, but that in treating of such subjects as these they are going out of their domain, and must do harm.

What is the domain of Science? It is all possible human knowledge which can rightly be used to guide human conduct.

In many parts of Europe it is customary to leave a part of the field untilled for the Brownie to live in because he cannot live in cultivated ground. And if you grant him this grace, he will do a great deal of your household work for you in the night while you sleep. In Scotland the piece of ground which is left wild for him to live in is called "the good man's croft." Now, there are people who indulge a hope that the ploughshare of Science will leave a sort of good man's croft around the field of reasoned truth; and they promise that in that case a good deal of our civilizing work shall be done for us in the dark, by means we know nothing of. I do not share this hope; and I feel very sure that it will not be realized. I think that we should do our work with our own hands, in a healthy, straightforward way. It is idle to set bounds to the purifying and organizing work of Science. Without mercy and without resentment, she ploughs up weed and briar; from her footsteps behind her grow up corn and healing flowers; and no corner is far enough to escape her furrow. Provided only that we take as our motto and our rule of action, "Man speed the plow."

ON THE NATURE OF THINGS IN THEMSELVES.

MEANING OF THE INDIVIDUAL OBJECT.

MY feelings arrange and order themselves in two distinct ways. There is the internal or subjective order, in which sorrow succeeds the hearing of bad news, or the abstraction "dog" symbolizes the perception of many different dogs. And there is the external or objective order, in which the sensation of letting go is followed by the sight of a falling object and the sound of its fall. The objective order, *quâ* order, is treated by physical science, which investigates the uniform relations of *objects* in time and space. Here the word *object* (or *phenomenon*) is taken merely to mean a group of my feelings, which persists as a group in a certain manner; for I am at present considering only the objective order of my feelings. The object, then, is a set of changes *in* my consciousness, and not anything out of it. Here is as yet no metaphysical doctrine, but only a fixing of the meaning of a word. We may subsequently find reason to infer that there is something which is not object, but which corresponds in a certain way with the object; this will be a metaphysical doctrine, and neither it nor its denial is involved in the present determination of meaning. But the determination must be taken as extending to all those inferences which are made by science in the objective order. If I hold that there is hydrogen in the sun, I mean that if I could get some of it in a bottle, and explode it with half its volume of oxygen, I should get that group of possible sensations which we call "water." The inferences of physical science are all inferences of my real or possible feelings; inferences of something actually or potentially in my consciousness, not of anything outside it.

DISTINCTION OF OBJECT AND EJECT.

There are, however, some inferences which are profoundly different from those of physical science. When I come to the conclusion that *you* are conscious, and that there are objects in your consciousness similar to those in mine, I am not inferring any actual or possible feelings of my own, but *your* feelings, which are not, and cannot by

any possibility become, objects in my consciousness. The complicated processes of your body, and the motions of your brain and nervous system, inferred from evidence of anatomical researches, are all inferred as things possibly visible to me. However remote the inference of physical science, the thing inferred is always a part of me, a possible set of changes in my consciousness bound up in the objective order with other known changes. But the inferred existence of your feelings, of objective groupings among them similar to those among my feelings, and of a subjective order in many respects analogous to my own—these inferred existences are in the very act of inference *thrown out* of my consciousness, recognized as outside of it, as *not* being a part of me. I propose, accordingly, to call these inferred existences *ejects*, things thrown out of my consciousness, to distinguish them from *objects*, things presented in my consciousness, phenomena. It is to be noticed that there is a set of changes of my consciousness symbolic of the eject, which may be called my conception of you ; it is (I think) a rough picture of the whole aggregate of my consciousness, under imagined circumstances like yours ; *qua* group of my feelings, this conception is like the object in substance and constitution, but differs from it in implying the existence of something that is not itself, but corresponds to it, namely, of the eject. The existence of the object, whether perceived or inferred, carries with it a group of beliefs ; these are always beliefs in the future sequence of certain of my feelings. The existence of this table, for example, as an object in my consciousness, carries with it the belief that if I climb up on it I shall be able to walk about on it as if it were the ground. But the existence of my conception of you in my consciousness carries with it a belief in the existence of you outside of my consciousness, a belief which can never be expressed in terms of the future sequence of my feelings. How this inference is justified, how consciousness can testify to the existence of anything outside of itself, I do not pretend to say ; I need not untie a knot which the world has cut for me long ago. It may very well be that I myself am the only existence, but it is simply ridiculous to suppose that anybody else is. The position of absolute idealism may, therefore, be left out of count, although each individual may be unable to justify his dissent from it.

FORMATION OF THE SOCIAL OBJECT.

The belief, however, in the existence of other men's consciousness, in the existence of ejects, dominates every thought and every action of our lives. In the first place, it profoundly modifies the object. This room, the table, the chairs, your bodies, are all objects in my consciousness ; as simple objects, they are parts of me. But I somehow infer the existence of similar objects in your consciousness, and these

are not objects to me, nor can they ever be made so ; they are ejects. This being so, I bind up with each object as it exists in my mind the thought of similar objects existing in other men's minds ; and I thus form the complex conception, "this table, as an object in the minds of men," or, as Mr. Shadworth Hodgson puts it, an object of consciousness in general. This conception symbolizes an indefinite number of ejects, together with one object which the conception of each eject more or less resembles. Its character is therefore mainly ejective in respect of what it symbolizes, but mainly objective in respect of its nature. I shall call this complex conception the *social object ;* it is a symbol of one thing (the *individual object*, it may be called for distinction's sake) which is in my consciousness, and of an indefinite number of other things which are ejects and out of my consciousness. Now, it is probable that the individual object, as such, never exists in the mind of man. For there is every reason to believe that we were gregarious animals before we became men properly so called. And a belief in the eject—some sort of recognition of a kindred consciousness in one's fellow-beings—is clearly a condition of gregarious action among animals so highly developed as to be called conscious at all. Language, even in its first beginnings, is impossible without that belief ; and any sound which, becoming a sign to my neighbor, becomes thereby a mark to myself, must by the nature of the case be a mark of the social object, and not of the individual object. But if not only this conception of the particular social object, but all those that have been built up out of it, have been formed at the same time with, and under the influence of, language, it seems to follow that the belief in the existence of other men's minds like our own, but not part of us, must be inseparably associated with every process whereby discrete impressions are built together into an object. I do not, of course, mean that it presents itself in consciousness as distinct ; but I mean that as an object is formed in my mind, a fixed habit causes it to be formed as a social object, and insensibly embodies in it a reference to the minds of other men. And this sub-conscious reference to supposed ejects is what constitutes the impression of *externality* in the object, whereby it is described as *not-me*. At any rate, the formation of the social object supplies an account of this impression of outness, without requiring me to assume any ejects or things outside my consciousness, except the minds of other men. Consequently, it cannot be argued from the impression of outness that there is anything outside of my consciousness, except the minds of other men. I shall argue presently that we have grounds for believing in non-personal ejects, but these grounds are not in any way dependent on the impression of outness, and they are not included in the ordinary or common-sense view of things. It seems to me that the prevailing belief of uninstructed people is merely a belief in the social object,

and not in a non-personal eject, somehow corresponding to it ; and that the question, whether the latter exists or not, is one which cannot be put to them so as to convey any meaning without considerable preliminary training. On this point I agree entirely with Berkeley, and not with Mr. Spencer.

DIFFERENCE BETWEEN MIND AND BODY.

I do not pause to show how belief in the Eject underlies the whole of natural ethics, whose first great commandment, evolved in the light of day by healthy processes wherever men have lived together, is, "Put yourself in his place." It is more to my present purpose to point out what is the true difference between body and mind. Your body is an object in my consciousness ; your mind is not, and never can be. Being an object, your body follows the laws of physical science, which deals with the objective order of my feelings. That its chemistry is ordinary chemistry, its physics ordinary physics, its mechanics ordinary mechanics, may or may not be true ; the circumstances are exceptional, and it is conceivable (to persons ignorant of the facts) that allowance may have to be made for them, even in the expression of the most general laws of nature. But in any case, every question about your body is a question about the physical laws of matter, and about nothing else. To say : "Up to this point science can explain ; here the soul steps in," is not to say what is untrue, but to talk nonsense. If evidence were found that the matter constituting the brain behaved otherwise than ordinary matter, or if it were impossible to describe vital actions as particular examples of general physical rules, this would be a fact in physics, a fact relating to the motion of matter ; and it must either be explained by further elaboration of physical science or else our conception of the objective order of our feelings would have to be changed. The question, "Is the mind a force?" is condemned by similar considerations. A certain variable quality of matter (the rate of change of its motion) is found to be invariably connected with the position relatively to it of other matter ; considered as expressed in terms of this position, the quality is called Force. Force is thus an abstraction relating to *objective* facts ; it is a mode of grouping of my feelings, and cannot possibly be the same thing as an eject, another man's consciousness. But the question : "Do the changes in a man's consciousness *run parallel* with the changes of motion, and, therefore, with the forces in his brain?" is a real question, and not *primâ facie* nonsense. Objections of like character may be raised against the language of some writers who speak of changes in consciousness as *caused* by actions on the organism. The word *Cause*, *πολλαχῶς λεγόμενον* and misleading as it is, having no legitimate place in science or philosophy, may yet be of some use in

conversation or literature, if it is kept to denote a relation between objective facts, to describe certain parts of the phenomenal order. But only confusion can arise if it is used to express the relation between certain objective facts in my consciousness and the ejective facts which are inferred as corresponding in some way to them and running parallel with them. For all that we know at present, this relation does not in any way resemble that expressed by the word Cause.

To sum up, the distinction between eject and object, properly grasped, forbids us to regard the eject, another man's mind, as coming into the world of objects in any way, or as standing in the relation of cause or effect to any changes in that world. I need hardly add that the facts do very strongly lead us to regard our bodies as merely complicated examples of practically universal physical rules, and their motions as determined in the same way as those of the sun and the sea. There is no evidence which amounts to a *primâ facie* case against the dynamical uniformity of Nature; and I make no exception in favor of that *slykick* force which fills existing lunatic asylums and makes private houses into new ones.

CORRESPONDENCE OF ELEMENTS OF MIND AND BRAIN-ACTION.

I have already spoken of certain ejective facts—the changes in your consciousness—as running parallel with the changes in your brain, which are objective facts. The parallelism here meant is a parallelism of complexity, an analogy of structure. A spoken sentence and the same sentence written are two utterly unlike things, but each of them consists of elements; the spoken sentence of the elementary sounds of the language, the written sentence of its alphabet. Now the relation between the spoken sentence and its elements is very nearly the same as the relation between the written sentence and its elements. There is a correspondence of element to element; although an elementary sound is quite a different thing from a letter of the alphabet, yet each elementary sound belongs to a certain letter or letters. And the sounds being built up together to form a spoken sentence, the letters are built up together, *in nearly the same way*, to form the written sentence. The two complex products are as wholly unlike as the elements are, but the manner of their complication is the same. Or, as we should say in the mathematics, a sentence spoken is the same function of the elementary sounds as the same sentence written is of the corresponding letters.

Of such a nature is the correspondence or parallelism between mind and body. The fundamental "deliverance" of consciousness affirms its own complexity. It seems to me impossible, as I am at present constituted, to have only one absolutely simple feeling at a

time. Not only are my objective perceptions, as of a man's head or a candlestick, formed of a great number of parts ordered in a definite manner, but they are invariably accompanied by an endless string of memories, all equally complex. And those massive organic feelings with which, from their apparent want of connection with the objective order, the notion of consciousness has been chiefly associated,—those also turn out, when attention is directed to them, to be complex things. In reading over a former page of my manuscript, for instance, I found suddenly, on reflection, that although I had been conscious of what I was reading I paid no attention to it; but had been mainly occupied in debating whether faint red lines would not be better than blue ones to write upon, in picturing the scene in the shop when I should ask for such lines to be ruled, and in reflecting on the lamentable helpnessness of nine men out of ten when you ask them to do anything slightly different from what they have been accustomed to do. This debate had been started by the observation that my handwriting varied in size according to the nature of the argument, being larger when that was diffuse and explanatory, occupied with a supposed audience; and smaller when it was close, occupied only with the sequence of propositions. Along with these trains of thought went the sensation of noises made by poultry, dogs, children and organ-grinders; and that vague diffused feeling in the side of the face and head which means a probable toothache in an hour or two. Under these circumstances, it seems to me that consciousness must be described as a succession of groups of changes, as analogous to a rope made of a great number of occasionally interlacing strands.

This being so, it will be said that there is a unity in all this complexity, that in all these varied feelings it is I who am conscious, and that this sense of personality, the self-perception of the Ego, is one and indivisible. It seems to me (here agreeing with Hume) that the "unity of apperception" does not exist in the instantaneous consciousness which it unites, but only in subsequent reflection upon it; and that it consists in the power of establishing a certain connection between the memories of any two feelings which we had at the same instant. A feeling, at the instant when it *exists*, exists *an und für sich*, and not as *my* feeling; but when on reflection I remember it as my feeling, there comes up not merely a faint repetition of the feeling, but inextricably connected with it a whole set of connections with the general stream of my consciousness. This memory, again, *qua* memory, is relative to the past feeling which it partially recalls; but in so far as it is itself a feeling, it is absolute, *Ding-an-sich*. The feeling of personality, then, is a certain feeling of connection between faint images of past feelings; and personality itself is the fact that such connections are set up, the property of the stream of feelings that part of it consists of links binding together faint reproductions of

previous parts. It is thus a relative thing, a mode of complication of certain elements, and a property of the complex so produced. This complex is consciousness. When a stream of feelings is so compact together that at each instant it consists of (1) new feelings, (2) fainter repetitions of previous ones, and (3) links connecting these repetitions, the stream is called a consciousness. A far more complicated grouping than is necessarily implied here is established when discrete impressions are run together into the perception of an object. The *conception* of a particular object, as object, is a group of feelings symbolic of many different perceptions, and of links between them and other feelings. The distinction between Subject and Object is two-fold ; first, the distinction with which we started between the subjective and objective *orders* which simultaneously exist in my feelings ; and secondly, the distinction between me and the social object, which involves the distinction between me and you. Either of these distinctions is exceedingly complex and abstract, involving a highly organized experience. It is not, I think, possible to separate one from the other ; for it is just the objective order which I do suppose to be common to me and to other minds.

I need not set down here the evidence which shows that the complexity of consciousness is paralleled by complexity of action in the brain. It is only necessary to point out what appears to me to be a consequence of the discoveries of Müller and Helmholtz in regard to sensation ; that at least those distinct feelings which can be remembered and examined by reflection are paralleled by changes in a portion of the brain only. In the case of sight, for example, there is a message taken from things outside to the retina, and therefrom sent in somewhither by the optic nerve ; now we can tap this telegraph at any point and produce the sensation of sight, without any impression on the retina. It seems to follow that what is known *directly* is what takes place at the inner end of this nerve, or that the consciousness of sight is simultaneous and parallel in complexity with the changes in the gray matter at the internal extremity and not with the changes in the nerve itself, or in the retina. So also a pain in a particular part of the body may be mimicked by neuralgia due to lesion of another part.

We come then, finally, to say that as your consciousness is made up of elementary feelings grouped together in various ways (ejective facts), so a part of the action in your brain is made up of more elementary actions in parts of it, grouped together *in the same ways* (objective facts). The knowledge of this correspondence is a help to the analysis of both sets of facts ; but it teaches us in particular that any feeling, however apparently simple, which can be retained and examined by reflection, is already itself a most complex structure. We may, however, conclude that this correspondence extends to the

elements, and that each simple feeling corresponds to a special comparatively simple change of nerve-matter.

THE ELEMENTARY FEELING IS A THING IN ITSELF.

The conclusion that elementary feeling co-exists with elementary brain-motion in the same way as consciousness co-exists with complex brain-motion, involves more important consequences than might at first sight appear. We have regarded consciousness as a complex of feelings, and explained the fact that the complex is conscious as depending on the mode of complication. But does not the elementary feeling itself imply a consciousness in which alone it can exist, and of which it is a modification? Can a feeling exist by itself, without forming part of a consciousness? I shall say *no* to the first question, and *yes* to the second, and it seems to me that these answers are required by the doctrine of Evolution. For if that doctrine be true, we shall have along the line of the human pedigree a series of imperceptible steps connecting inorganic matter with ourselves. To the later members of that series we must undoubtedly ascribe consciousness, although it must, of course, have been simpler than our own. But where are we to stop? In the case of organisms of a certain complexity consciousness is inferred. As we go back along the line, the complexity of the organism and of its nerve-action insensibly diminishes; and for the first part of our course we see reason to think that the complexity of consciousness insensibly diminishes also. But if we make a jump, say to the tunicate molluscs, we see no reason there to infer the existence of consciousness at all. Yet not only is it impossible to point out a place where any sudden break takes place, but it is contrary to all the natural training of our minds to suppose a breach of continuity so great. All this imagined line of organisms is a series of objects in my consciousness; they form an insensible gradation, and yet there is a certain unknown point at which I am at liberty to infer facts *out* of my consciousness corresponding to them! There is only one way out of the difficulty, and to that we are driven. Consciousness is a complex of ejective facts—of elementary feelings, or rather of those remoter elements which cannot even be felt, but of which the simplest feeling is built up. Such elementary ejective facts go along with the action of every organism, however simple; but it is only when the material organism has reached a certain complexity of nervous structure (not now to be specified) that the complex of ejective facts reaches that mode of complication which is called "consciousness." But as the line of ascent is unbroken, and must end at last in inorganic matter, we have no choice but to admit that every motion of matter is simultaneous with some ejective fact or

event which might be part of a consciousness. From this follow two important corollaries:

1. A feeling can exist by itself, without forming part of a consciousness. It does not depend for its existence on the consciousness of which it may form a part. Hence a feeling (or an eject-element) is *Ding-an-sich*, an absolute, whose existence is not relative to anything else. *Sentitur* is all that can be said.

2. These eject-elements, which correspond to motions of matter, are connected together in their sequence and co-existence by counterparts of the physical laws of matter. For otherwise the correspondence could not be kept up

MIND STUFF IS THE REALITY WHICH WE PERCEIVE AS MATTER.

That element of which, as we have seen, even the simplest feeling is a complex, I shall call *mind-stuff*. A moving molecule of inorganic matter does not possess mind or consciousness; but it possesses a small piece of mind-stuff. When molecules are so combined together as to form the film on the under side of a jelly-fish, the elements of mind-stuff which go along with them are so combined as to form the faint beginnings of Sentience. When the molecules are so combined as to form the brain and nervous system of a vertebrate, the corresponding elements of mind-stuff are so combined as to form some kind of consciousness; that is to say, changes in the complex which take place at the same time get so linked together that the repetition of one implies the repetition of the other. When matter takes the complex form of a living human brain, the corresponding mind-stuff takes the form of a human consciousness, having intelligence and volition.

Suppose that I see a man looking at a candlestick. Both of these are objects, or phenomena, in my mind. An *image* of the candlestick, in the optical sense, is formed upon his retina, and nerve messages go from all parts of this to form what we may call a *cerebral image* somewhere in the neighborhood of the optic thalami in the inside of his brain. This cerebral image is a certain complex of disturbances in the matter of these organs; it is a material or physical fact, therefore a group of my possible sensations, just as the candlestick is. The cerebral image is an imperfect representation of the candlestick, corresponding to it point for point in a certain way. Both the candlestick and the cerebral image are matter; but one material complex *represents* the other material complex in an imperfect way.

Now, the candlestick is not the external reality whose existence is represented in the man's mind; for the candlestick is a mere perception in *my* mind. Nor is the cerebral image the man's perception of the candlestick; for the cerebral image is merely an idea of a possible

perception in my mind. But there *is* a perception in the man's mind, which we may call the *mental image;* and this corresponds to some external reality. *The external reality bears the same relation to the mental image that the (phenomenal) candlestick bears to the cerebral image.* Now, the candlestick and the cerebral image are both matter; they are made of the same stuff. Therefore the external reality is made of the same stuff as the man's perception or mental image—that is, it is made of mind-stuff. And as the cerebral image represents imperfectly the candlestick, in the same way and to the same extent the mental image represents the reality external to his consciousness. Thus in order to find the thing in itself which is reprerented by any object in my consciousness, such as a candlestick, I have to solve this question in proportion, or rule of three :—

As the physical configuration of my cerebral image of the object
is to the physical configuration of the object,
so is my perception of the object (the object regarded as complex of my feelings)
to the thing in itself.

Hence we are obliged to identify the thing in itself with that complex of elementary mind-stuff which on other grounds we have seen reason to think of as going along with the material object. Or, to say the same thing in other words, the reality external to our minds which is represented in our minds as matter is in itself mind-stuff.

The universe, then, consists entirely of mind-stuff. Some of this is woven into the complex form of human minds containing imperfect representations of the mind-stuff outside them, and of themselves also, as a mirror reflects its own image in another mirror, *ad infinitum.* Such an imperfect representation is called a material universe. It is a picture in a man's mind of the real universe of mind-stuff.

The two chief points of. this doctrine may be thus summed up :—

Matter is a mental picture in which mind-stuff is the thing represented.

Reason, intelligence and volition are properties of a complex which is made up of elements themselves not rational, not intelligent, not conscious.

NOTE.—The doctrine here expounded appears to have been arrived at independently by many persons; as was natural, seeing that it is (or seems to me) a necessary consequence of recent advances in the theory of perception. Kant[1] threw out a suggestion that the

[1] "Kritik der reinin Vernunft," pp. 287, 288, ed. Rosenkranz. Wundt's statement is in the concluding paragraphs of "Grundzüge der physiologischen Psychologie." Compare, too, Häckel, "Zellseelen und Seelenzellen," in "Deutsche Rundschau," July, 1878, vol. xvi., p. 40.

Ding-an-sich might be of the nature of mind ; but the first statement of the doctrine in its true connection that I know of is by Wundt. Since it dawned on me, some time ago, I have supposed myself to find it more or less plainly hinted in many writings ; but the question is one in which it is peculiarly difficult to make out precisely what another man means, and even what one means one's self.

Some writers (*e. g.*, Dr. Tyndall) have used the word "matter" to mean the phenomenon *plus* the reality represented ; and there are many reasons in favor of such usage in general. But for the purposes of the present discussion I have thought it clearer to use the word for the phenomenon as distinguished from the thing in itself.

ON THEORIES OF THE PHYSICAL FORCES.[1]

[REFERRING to the passage in *Faust*—

"Geschrieben steht: Im Anfang war das Wort.
Hier stock' ich schon! Wer hilft mir weiter fort?
Ich kann das Wort so hoch unmöglich schätzen,
Ich muss es anders übersetzen,
Wenn ich vom Geiste recht erleuchtet bin.
Geschrieben steht: Im Anfang war der Sinn.
Bedenke wohl die erste Zeile,
Dass deine Feder sich nicht übereile!
Ist es der Sinn, der alles wirkt und schafft?
Es sollte stehn: Im Anfang war die Kraft!
Doch, auch indem ich dieses niederschreibe,
Schon warnt mich was, dass ich dabei nicht bleibe.
Mir hilft der Geist! Auf einmal seh' ich Rath,
Und schreibe getrost: Im Anfang war die That!"

the speaker regarded it as a description of four views or stages of opinion through which a man looking for himself on the face of things is likely to pass; through which also successive generations of the men who look for themselves on the face of things are likely to pass. He considered that by far the larger portion of scientific thought at the present day is in the third stage—that, namely, in which Force is regarded as the great fact that lies at the bottom of all things; but that this is so far from being the final one, that even now the fourth stage is on its heels. In the fourth stage the conception of Force disappears, and whatever happens is regarded as a deed. The object of the discourse was to explain the nature of this transition, and to introduce certain conceptions which might serve to prepare the way for it.

There are, then, to be considered two different answers to the question, "What is it that lies at the bottom of things?" The two answers correspond to two different ways of stating the question,

[1] Discourse delivered at the Royal Institution, February 18, 1870. This discourse is reprinted as it stands in the Proceedings of the Royal Institution. The opening paragraphs, being reported in the third person and apparently abridged, are inclosed in square brackets.

namely, first, "Why do things happen?" and secondly, "What is it precisely that does happen?" The speaker maintained that the first question is external to the province of science altogether, and science has nothing to do with it; but that the second is exactly the question to which science is always trying to find the answer. It may be doubted whether the first question is within the province of human knowledge at all. For it is as necessary that a question should *mean something* in order to be a real question, as that an answer should mean something in order to be a real answer. And it is quite possible to put words together with a note of interrogation after them without asking any real question thereby. Whether the phrase, "Why do things happen?" as applied to physical phenomena, is a phrase of this kind or not, is not here to be considered. But that to the scientific inquirer there is not any "*why*" at all, and that if he ever uses the word it is always in the sense of *what*, the speaker regarded as certain. In order to show what sort of way an exact knowledge of the facts would supersede the inquiry after the cause of them, he then made use of the hypothesis of continuity; showing, in the following manner, that it involves such an interdependence of the facts of the universe as forbids us to speak of one fact or set of facts as the *cause* of another fact or set of facts.]

The hypothesis of the continuity of space and time is explained, and the alternative hypothesis is formulated.

From the hypothesis of the complete continuity of time-changes, a knowledge of the entire history of a single particle is shown to be involved in a complete knowledge of its state at any moment.

Things frequently move. Some things move faster than others. Even the same thing moves faster at one time than it does at another time. When you say that you are walking four miles an hour, you do not mean that you actually walk exactly four miles in any particular hour; you mean that if anybody did walk for an hour, keeping all the time exactly at the rate at which you are walking, he would in that hour walk four miles. But now suppose that you start walking four miles an hour, and gradually quicken your pace, until you are walking six miles an hour. Then this question may be asked: Suppose that anybody chose a particular number between four and six, say four and five-eighths, is it perfectly certain that at some instant or other during that interval you were walking at the rate of four miles and five-eighths in the hour? Or, to put it more accurately, suppose that we have a vessel containing four pints of water exactly, and that somebody adds to it a casual quantity of water less than two pints. Then is it perfectly certain that between these two times, when you were walking at four miles an hour, and when you were walking six miles an hour, there was some particular instant at which you were walking exactly as many miles and fractions

of a mile an hour as there are pints and fractions of a pint of water in the vessel? The hypothesis of continuity says that the answer to this question is yes; and this is the answer which everybody gives nowadays; which everybody has given mostly since the invention of the differential calculus.

But this is a question of fact, and not of calculation. Let us, therefore, try and imagine what the contrary hypothesis would be like.

You know what a "wheel of life" is. There is a cylinder with slits in its side, which can be spun round rapidly; and you look through the slits at the pictures opposite. The result is that you see the pictures moving; moreover, you see them move faster or slower according as you turn the cylinder faster or slower. This is what you see, and what appears to happen; but now let us consider what actually does happen. I remember in particular a picture of a man rolling a ball down an inclined plane toward you; he was standing at the further edge of the inclined plane, as it were behind a counter, and he picked up the balls one by one and rolled them toward you. But now when you took out the strips of paper on which the pictures were drawn, you found that they were really pictures of this man and his ball in a graduated series of positions. Each picture, of course, was perfectly still in itself, a mere drawing on the paper. The first one represented him with his hand below the counter, just picking up the ball; in the next, he had the ball in his hand, drawn back ready to roll down; in the next, the hand was thrown forward with the ball in it; in the next, the ball had just left his hand and rolled a little way down; in the next, farther, and so on. Now, these pictures being put in the inside of the cylinder which is turning round, come opposite to you one by one. But you do not look directly at them; there are slits interposed. The effect of that is, that if you look straight at a certain portion of the opposite picture you can only see it for a very small interval of time; that, namely, during which the slit is passing in front of your eye. Now, let us carefully examine what happens. When the slit passes, it goes so quickly that you get, as it were, almost an instantaneous photograph on your eye of the opposite picture; say of the man with his hand below the counter. Then this is effaced, and you see absolutely nothing until the next slit passes. But by the time the next slit comes, another picture has got opposite to you; so that you get an instantaneous photograph this time of the man with his hand drawn back and the ball in it. Then this in its turn is effaced, for a time you see nothing, and then you are given an instantaneous glimpse of the hand thrown forward. In this way, what you really see is darkness relieved by regularly recurring glimpses of the figure in different positions. Now, this experience that you get is obviously consistent with the hypothesis that the man goes on moving all the time when he is hidden from you; so as to be in

exactly that series of positions when you do catch a glimpse of him. And, in fact, you do instinctively, by an inevitable habit, admit this hypothesis, not merely into your mind as a speculation, but into your very sensation as an observed phenomenon. You simply see the man move; and, except for a certain weariness in the eyes, there is nothing to distinguish this perception of movement from any other perception of movement. At the same time we do know very distinctly, and beyond the shadow of a doubt, that there is no continuity in the picture at all; that, in fact, you do not see the same picture twice following, but a new one every time till the cycle is completed; and that the picture never is in any position intermediate between two successive ones of those which you see. Here then is an apparently continuous motion which is really discontinuous; and moreover there is an apparently continuous perception of it which is really discontinuous—that is, it seems to be gradually changed, while it really goes by little jumps.

I suppose very few people have looked at this toy without wondering whether it is not actually and truly a wheel of life, without any joke at all. I mean, that it is very natural for the question to present itself: Do I ever really see anything move? May not all my apparently continuous perceptions be ultimately made up of little jumps, which I run together by this same inevitable instinct? There is another way in which this is sometimes suggested. If you move your hand quickly, you can see a continuous line of light, because the image of every position of your hand lingers a little while upon the retina. But now, if you do this in a room lighted only by an electric spark which is not going very fast, so that the general result is darkness broken by nearly instantaneous flashes at regular intervals; then, instead of seeing a continuous line of light, you will see a distinct series of different hands, perhaps about an inch apart, if the electric spark is going very slowly and you move your hand very quickly. But now make the spark go quicker or your hand slower; the distances between these several hands will gradually diminish till —you do not know how—the continuous line of light is restored. And the question inevitably presents itself: Is not every case of apparently continuous perception really a case of successive distinct images very close together?

That is to say, for instance, if I move my hand so in front of me, and apparently see it take up in succession every possible position on its path between the two extreme positions; do I really see this, or do I only see my hand in a certain very large number of distinct positions, and not at all in the intervening spaces?

I have no doubt whatever myself that the latter alternative is the true one, and that the wheel of life is really an illustration and type of every moment of our existence. But I am not going to give my

reasons for this opinion, because it is quite a different question from the one I am trying to get at. The question, namely, is this. What I see, or fancy I see, is quite consistent with the hypothesis that my hand really does go on moving continuously all the time, and takes up an infinite number of positions between the two extreme ones. But if this hypothesis is not true, what is true? and how are we to imagine any other state of things than that supposed by the hypothesis of continuity?

I draw here two rows of points. The upper row of points is to represent a series of positions in space which it is conceivable that a certain thing might take up. The lower row of points is to represent a series of instants in time at which it is conceivable that the same thing might exist. Suppose now that at the instant of time represented by the first point of the lower row, the thing held the position in space represented by the first point of the upper row. Suppose that it only existed there for that instant, and then disappeared utterly, so that at these succeeding instants where the lower points have no points directly above them, the thing is nowhere at all. Lastly, suppose that at this instant of time which *has* a space-dot above it, the thing existed in that space-position ; and so on all through, the thing only existing at those instants whose representative points have a space-dot exactly above them, and being then in the space-position signified by such dots. Then we may call this a discontinuous motion ; a motion because the thing is in different places at different times, though it is not at all times that it exists at all ; and a discontinuous motion because the thing passes from one position to another *distant* from it without going through any intermediate position.

Now, imagine that in each of these two series the dots are very close together indeed, and very great in number ; so that, however small one made them on the paper, the lines would look as if they were continuous lines. And let the thing be a white speck traveling along the upper line in the manner I have described ; namely, existing only when there is one dot exactly over another ; only that as the lower dots represent instants of time, we may make some definite supposition and assume that one inch of them represents a second.

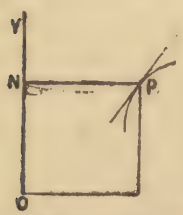
Then it is clear that if the dots were taken close enough together, and enough of them, the appearance would be precisely what we ordinarily see when a white speck moves along a line. That is to say, we have got some sort of representation of what we might have to suppose, if we did not assume the truth of the law of continuity.

You must here notice in particular that I suppose the series of positions denoted by the upper dots to be *all* the positions that are between the two end ones ; that is, I suppose the path from one of these end ones to the other to be made up of a series of discrete positions. And similarly I suppose the series of instants denoted by

the lower dots to be *all* the time that elapses between the two end ones; that is, I suppose the interval of time to contain a perfectly definite number of instants, these being further indivisible. Or we may say that on this alternative hypothesis space and time are discontinuous; that is, they are in separate parts which do not hold together. Now I must beg you to remember for a little while what the hypothesis of continuity is *not*, for I shall have to refer to this point again subsequently. In this kind of jumping motion that we have been imagining, the rate of motion of a thing could only be measured by the size of one of its jumps; that is, by the number of positions it passed over between two existences compared with the number of instants passed over. And this rate might obviously change by jumps as violent and sudden as those of the thing itself; at any instant when the thing was non-existent its rate would be non-existent, and whenever the thing came into existence its rate would suddenly have a value depending on how far off its last position was. In this case, therefore, our question about the intermediate rate—whether between walking four miles an hour and walking six miles an hour you must necessarily walk at all intermediate paces—must be answered in the negative. Now then, at last, let us investigate some consequences of supposing that motion is really continuous as it seems to be.

First, how to measure the rate at which a thing is moving? This was done experimentally by Galileo in the case of falling bodies, and I shall have to speak again of the results which he obtained. But at present I want to speak not of an experimental method of finding the rate, but of a theoretical method of representing it, invented by Newton, and called the curve of velocities.

Suppose that a point N is going along the line O Y, sometimes fast and sometimes slow; and that a point M is going along the line O X, always at the same rate. Also somebody always holds a stick N P so as to move with the point N, and be horizontal; and somebody holds a stick M P so as to move with the point M, and be vertical; and a third person keeps a pencil pressed in the corner where the two sticks cross at P. Then, when the points M and N move, the point P will move too; and its motion will depend on that of the two other points. For instance, if the point N moves always exactly as fast as the point M, then the point P will go along the line O P midway between the lines O X O Y. If N moves twice as fast as M always, the point P will go along a line nearer O Y; and if N moves only half as fast as M, then P will go along a line nearer O X. And in general, the faster N moves, the more the line will be tilted up; and if the rate at which N goes is changeable, the direction of P's motion will be changeable, and P



will then describe a curve, which will be very steep when N is going fast, and more flat when N is going slow. So that the steepness of this curve is now a visible measure of the rate at which N is going, and the *curvature* of it is a visible expression of the fact that the rate is changeable. Now the hypothesis of continuity in the motion of N asserts not merely that N itself moves without any jumps, but that the rate at which N is going changes gradually without any jumps, and consequently that the direction of P's motion changes gradually; or that the curve described by P cannot have a sharp point like this. But it asserts a great deal more besides this, which I shall now endeavor to explain. Let us imagine a new point N^1, so moving that whenever the old N is going at four inches a second, N^1 shall be four inches from O; and when N is going at two inches a second, N^1 shall be two inches from O, and so on, the distance of N^1 from O being always exactly as far as N would go in a second if it went at the rate at which it was moving at that instant. Then the distance $O\ N^1$ measures the *rate* at which N is going, or the *velocity* of N. If, for example, there was a thing like a thermometer hung up in a train, so that the height of the mercury always indicated how fast the train was going; when the train was going seventeen miles an hour, the mercury stood at seventeen inches, and so on; then the top of the mercury would behave toward the train exactly as I want the point N^1 to behave toward the point N. It is to indicate by its height how fast N is going.

If, then, the velocity of N is changeable, the point N^1 will move up and down; and the rate at which N^1 moves up or down is clearly the rate at which the velocity of N is increasing or diminishing. This rate at which the velocity of N changes is called its acceleration. To return to our gauge instead of a train, if in the course of a minute it went up from seventeen to nineteen, the train would be said to have an acceleration of two miles an hour per minute.

Now I shall take another point N^2, which is to behave toward N^1 exactly as N^1 behaves toward N; namely, the distance of N^2 from O^2 is to be always equal to the number of inches which N^1 is going in a second. And then I shall take a point N^3, related in just this same way to N^2, and so on, until I come to a point that does not move at all; and that I might never come to, so that I should have to go on taking new points forever. But suppose now that I have got this series of points, and that they are all moving together. Then, first of all, there is my point N, which moves anyhow. Next there is N^1, such that $O^1\ N^1$ is the velocity of N, or the rate of change of N's position. Next there is N^2, such that $O^2\ N^2$ is the acceleration of N, or the rate of change of the rate of change of N's position. Then again $O^3\ N^3$ is the change of the acceleration of N, or the rate of change of the rate of change of the rate of change of N's position, and so on. We may,

if we like, agree to call the velocity of N the change of the first order, the velocity of N' the change of the second order, and so on.

Then the hypothesis of the perfect continuity of N's motion asserts that all these points move continuously without any jumps. Now, a jump made by any one of these points, being a finite change made in no time, would be a change made at an infinite rate; the next point, therefore, and all after it, would go right away from O, and disappear altogether. We may thus express the law of continuity also in this form; that there is no infinite change of any order.

Now, observe further that the rate at which anything is going is a property of the thing at that instant, and exists whether the thing goes any more or not. If I drop a marble on the floor, it goes faster and faster till it gets there, and then stops; but at the instant when it hit the floor it was going at a perfectly definite rate, which can be calculated, though it did not actually go any more.

In the same way the configuration of all these points which depend on the point N is a property of its motion at any given instant, quite independent of the continuance of that motion. I want you to take particular notice of this fact, that as the point N moves about, the whole set of points connected with it moves too; and that you may regard them as connected by some machine, which you may stop at any moment to contemplate the simultaneous positions of all these points; and that this set of simultaneous positions belongs just simply to that one position of the point N, and therefore to one instant of time.

Now I am going to state to you dogmatically a certain mathematical theorem, called Taylor's theorem; whereby you will see the very remarkable consequences of this hypothesis that we have made.

Namely, there is a certain rule whereby when the positions of all these points are known for any particular instant of time, then their positions at any other instant of time may be calculated from these; and it is impossible that they should have at that other instant any other positions than those so calculated. Provided always that there is no infinite change of any order; that is to say, that no one of the points has taken a sudden jump and sent all the points after it away to an infinite distance from O at any instant between the one for which the positions are given and the one for which they are calculated.

Remember that the positions of all the derivative points are mere properties of the motion of the point N at any instant; that in fact we must know them all in order to know completely the state of the point N at that instant. And then observe the result that we have arrived at. From the knowledge of the complete state at any instant of a thing whose motion obeys the law of continuity, we can calculate where it was at any past time, and where it will be at any future time.

Now the hypothesis of continuity, of which we have only got disjointed fragments hitherto, is this : that the motion of every particle of the whole universe is entirely continuous. It follows from this hypothesis that the state at this moment of any detached fragment—say a particle of matter at the tip of my tongue—is an infallible record of the eternal past, an infallible prediction of the eternal future.

This is not the same as the statement that a complete knowledge of the position and velocity of every body in the universe at a given moment would suffice to determine the position at any previous or subsequent moment. That depends on an entirely different hypothesis, and relates to the whole, while this proposition that I am now expounding relates to every several part however small. Now reflect upon the fact that for a single particle—quite irrespective of everything else—the history of eternity is contained in every second of time ; and then try if you can find room in this one stifling eternal fact for any secondary causes and the question why. Why does the moon go round the earth? When the Solar system was nebulous, anybody who knew all about some one particle of nebulous vapor might have predicted that it would at this moment form part of the moon's mass, and be rotating about the earth exactly as it does. But why with an acceleration inversely as the square of the distance? There is no why ; the fact is probably equivalent to saying that the continuous motion of one body is such as not to interfere with the continuous motion of another. If once so, then always ; the cause is only the fact that at some moment the thing is so—or rather, the facts of one time are not the cause of the facts of another, but the facts of all time are included in one statement, and rigorously bound up together.

Parallel, however, with this hypothesis of temporal continuity, there is another hypothesis, not so universally held, of a continuity in space ; for which indeed I hope to make more room presently. And out of this it appears that as the history of eternity is written in every second of time, so the state of the universe is written in every point of space.

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