THE DOCTRINE

OF

HUMAN AUTOMATISM.

A LECTURE

(*WITH ADDITIONS*)

DELIVERED BEFORE

THE SUNDAY LECTURE SOCIETY,

On Sunday Afternoon, 7th March, 1875.

BY

W. B. CARPENTER, LL.D., M.D.,
F.R.S., F.L.S., F.G.S.

CORRESPONDING MEMBER OF THE INSTITUTE OF FRANCE,
AND REGISTRAR OF THE UNIVERSITY OF LONDON.

LONDON:
PUBLISHED BY THE SUNDAY LECTURE SOCIETY.
1875.

Price Threepence.

SUNDAY LECTURE SOCIETY,

To provide for the delivery on Sundays in the Metropolis, and to encourage the delivery elsewhere, of Lectures on Science—physical, intellectual, and moral,—History, Literature, and Art; especially in their bearing upon the improvement and social well-being of mankind.

THE SOCIETY'S LECTURES

ARE DELIVERED AT

ST. GEORGE'S HALL, LANGHAM PLACE,

On SUNDAY Afternoons, at FOUR o'clock precisely

(Annually—from November to May).

TWENTY-FOUR Lectures (in three series), ending 2nd May, 1875, will be given.

Members' £1 subscription entitles them to an annual ticket (transferable, and admitting to the reserved seats), and to eight single reserved-seat tickets available for any lecture.

Tickets for each series (one for each lecture), as below:—

To the SHILLING Reserved Seats—**5s. 6d.**

To the SIXPENNY Seats—**2s.**, being at the rate of THREEPENCE each lecture.

For tickets apply (by letter) to the Hon. Treasurer, WM. HENRY DOMVILLE, Esq., 15 Gloucester Crescent, Hyde Park, W.

Payment at the door:—ONE PENNY;—SIXPENCE;—and (Reserved Seats) ONE SHILLING.

IS MAN AN AUTOMATON?

LADIES AND GENTLEMEN,—In introducing to you the question which is to be the subject of my address this evening—the question, Is Man an Automaton?—it is perhaps well that I should define, at the commencement, the sense in which I intend to use these words; and it will be more convenient to take the second first—What do I mean by an Automaton? The word automaton is derived from two Greek words, which mean self-moving. Well, of course, man is a self-moving being, and in that sense he is an automaton. But the word automaton, as we use it, has a different signification. It means a structure which moves by a mechanism, and which can only move in a certain way. I might take as illustrations various automata which are exhibited from time to time—I remember to have seen in my boyhood many remarkable collections. But I will draw my illustration from this very hall in which we are met. The great organ behind me is blown, I understand, by water power. You know, I daresay, that formerly organs were blown by manual or human power. The bellows-blower had before him what is called a "tell-tale," a little weight so hung as to indicate the amount of wind in the organ; and his business was to work the bellows so as always to keep the "tell-tale" below a certain point. On the other hand, by a piece of mechanism constructed for the purpose with a great deal of skill, the organ is now blown by water-pressure. The water-pressure so acts, that when the organist requires a large supply of wind, as when he is playing loud through a great many pipes, the bellows

move faster and supply that wind; while, on the other hand, when he plays softly, and little wind is required, the bellows move more slowly. If that apparatus were incased in the frame of a human figure, and made to work the bellows-handle up and down, we should call it an automaton.

Now, let us see on what the working of that automaton depends. It depends, in the first place, upon its structure. The mechanist who has constructed that apparatus has so arranged the play of its various parts, that it shall work with the power communicated to it, in accordance with the organist's requirements. Then its working depends upon the force supplied by the water-pressure; that force being made, by the construction of the machine, to exert itself in moving the bellows at the rate determined by the playing of the organist. Without a sufficient water-pressure the machine will not work; and when the organist ceases to touch the keys, the movement of the bellows comes to a stand. There you have then a machine which is moved, on the one hand, by a certain power, and the action of which is regulated by another set of circumstances external to itself. Now that is, I think, what we mean by an automaton—a machine which has within itself the power of motion, under conditions fixed *for* it, but not *by* it. A watch, for instance, is an automaton. You wind it up and give it the power of movement; while you make it regulate itself by its balance, which you can so adjust as to make it keep accurate time. Any piece of mechanism of that sort, self-moving and self-regulating, is an automaton. But then all these machines are made to answer certain purposes, and cannot go beyond. They are entirely dependent, first, upon their original construction, secondly, upon the force which is applied to them, and thirdly, upon the conditions under which that force is made to act. The question then is, whether Man is a machine of that kind?—his original constitution, derived from his ancestry, in the first place, shaping the mechanism of his body; and in the second place, the circumstances acting upon him through the whole period of his growth, and modifying the formation of his body, also, in the same manner, determining the constitution of his mind. Are we to regard the whole subse-

quent life (mental as well as bodily) of each individual, with his course of action in the world, as a necessary consequence or resultant of these conditions—as strictly determined by his inherited and acquired organisation, and by the external circumstances which act upon it?

We must now consider what we understand by Man. I do not mean Man according to the zoologist's definition—a Vertebrate animal, belonging to the class *Mammalia*, order *Bimana*, genus and species *Homo sapiens;* but Man as he is familiarly known to us, and as we have to regard him in our present inquiry—the bodily man and the mental man. We cannot help separating these two existences in thought, although my own course of study has been directed to the investigation of the nature of their relation. The metaphysician considers man simply in his mental aspect; but he cannot help dealing with the organs of sensation, and the mode in which man acquires his knowledge of the external world through those organs; nor can he help dealing with the subject of voluntary action, and with the movements which express mental emotions. The physiologist, on the other hand, looks simply at the body of man; and yet he cannot help dealing with the physiological conditions of mental activity—the way in which we become conscious of the impressions made upon the organs of sense, and the mode in which the mind acts upon the muscular apparatus. A little consideration will shew that we may justly regard the body of man as the instrument by which his mind comes into relation with the external world. We all know that "I" means something distinct from the external world; and it is found convenient to call that personality by the Latin term *Ego*. This Ego—which feels, thinks, reasons, judges, and determines—receives all its impressions of the external world through the instrumentality of the body. Again, all the action of the Ego upon the external world—including in that term the minds of other men—is exerted through the instrumentality of the body. What am I doing at the present time?—endeavouring to excite in your minds certain ideas which are passing through my own. How do I do so?—by means of my organs of speech, which are regulated by my nervous system; that apparatus being the instrument

through which my mind expresses my ideas in spoken language. The sounds I utter, transmitted to you by vibrations of the air falling upon your ears, excite in the nerves with which those organs are supplied certain changes which are propagated through them to the sensorium, that wonderful organ through the medium of which a certain state of consciousness is aroused in your minds; and my aim is, by the use of appropriate words, to suggest to your minds the ideas I desire to implant in them.

Such is the aspect under which I would have you consider Man's body this evening. I do not say it is the only aspect: but it best suits our present discussion to consider the body as the instrument by which the mind of each individual is made conscious of what is taking place around him, and by which he is able to act upon the external world; thus becoming the instrument of communication between one mind and another. To illustrate what I would have you keep before you strongly—that the Mind is the essential Ego—I will ask your attention to one or two facts of very familiar experience. It must have happened to most of you to have formed impressions of other individuals without any knowledge of their bodily appearance. We do not know them in the flesh at all, but we know them intimately, or think we do, in the spirit. I remember, in the year 1851, the year of the first great Exhibition, being told that a number of the Telegraph establishments in the country having given their clerks a free ticket to London, to enable them to go up and see the world's fair—as it was called—in Hyde Park, almost every clerk on first coming to Town, before going to the great Exhibition, went down to the telegraph office in the city to fraternise with his chum. You probably know that telegraph clerks very soon find out who is at the "other end." Several clerks occasionally work a particular instrument, and each comes to know in half a dozen signals who has "gone on." They recognise the style of telegraphing, just as you would recognise the handwriting of a friend. After a little there is some one whom each comes to like better than others; A communicates individually with B, and B with A; and beginning with the exchange of little friendly messages at odd times, intimacies, I have been

assured, of the most fraternal kind, frequently spring up between those who have never seen each other. I daresay, now that young ladies are employed in telegraphing—and a most fitting employment it is for them—some more tender relations may spring up in the same manner.

Take again another illustration—the way in which our sympathies are aroused with an author, when we come to know his mind as presented in his writings. A great many of you felt when Dickens died, as if you had lost a personal friend—one with whose mind your own had grown into close relation, whose thoughts had exercised a most valuable influence on yours, and whom you felt to be nearer to you than many so-called friends.

Let me give you an instance from my own experience. I have been for some years a great admirer of an American writer, whose books I have read with the deepest interest, because I found in these books expressions of some of my own best thoughts, a great deal better put forth than I could put them forth myself—the products of a similar course of scientific inquiry, worked out with the aid of great poetic insight and a great fund of human sympathy, —a large human capacity altogether. In his writings I have felt as if I had one of my nearest and truest friends. Circumstances lately drew forth a letter from him to myself, in which he did me the honour to say that I had been his teacher in science; but I felt he was completely my master in everything that gives the best expression to scientific thoughts. Now if I were to go to America, the first man with whom I should seek to make acquaintance, with the certainty that we should meet as old personal friends, is Oliver Wendel Holmes.—I do not speak of Ralph Waldo Emerson, because we have long been personal friends. In the preface to a book I have lately received from him, he sums up all I have been now saying in these pregnant words—"Thoughts rule the world."

Thus it is the mind that reciprocates the mind, much more than the body reciprocates the body. The body is the symbol of the mind, just as spoken or written words are symbols of ideas; and when we think of a friend whom we know personally, we combine with the conception of his personality our whole knowledge and conception of his

character. When you say, "I met my friend so and so in the street," you do not mean you met simply his body, but that you met the man—the whole man. But when you say that you know a man "by sight" only, you mean that you know his outside body and nothing more.

In considering the body as the instrument of the mind, I shall shew you, first, the large amount of automatism in the human body, as to which I want you to have clear ideas. I do not wish, for any purpose whatever, to lead you away from this truth. I wish that you should be in the position yourselves to appreciate facts, so as not to be led away by one-sided statements. I desire particularly that my statements should not be one-sided; and so far as time will allow, I will place before you the whole of the most important considerations relating to this subject.

We must separate our body into two parts; and shall first consider the part that is most important as the instrument of our mind—that which physiologists call the *apparatus of animal life*. This takes in the nervous system—the recipient of impressions made by the external world upon our organs of sense, the instrument through which these impressions are enabled to affect our conscious minds, and conversely the medium through which our minds express themselves in action on our bodies. Then, again, there is the muscular apparatus, which is called into action through the nervous system, and the framework of bones and joints by which this muscular apparatus gives movement to the several parts of the body.

But this "apparatus of animal life" cannot be maintained in its integrity, and cannot perform the actions which it is adapted to execute, without certain conditions. It must be maintained by nutrition, because it is always wearing and wasting by its very action, and is in constant need of repair; and the material for this repair must be supplied by the blood-circulation. Again, the power it puts forth is dependent upon the operation of oxygen on the material of its tissues or of the blood which circulates through them; and this is as essential a condition as the pressure of water is upon the bellows of the organ.

Then the circulation of the blood involves the preparation of the blood from food, and its exposure to the atmo-

sphere in the lungs, so as to get rid of the carbonic acid which is the product of the chemical change that generates nervo-muscular energy, and may take in a fresh supply of oxygen; and hence there is required an *apparatus of organic life*. This apparatus consists of all the organs which take in the food, which digest it, prepare it, and convert it into blood, those which circulate the blood, and also those which subject the blood to the influence of the air. The working of this apparatus in man involves the action of certain nerves and muscles; though it is not so with many of the lower animals, which are provided with a much simpler mechanism. In the case of man we have the need of muscles to take in and swallow the food, and of muscles to move the coats of the stomach in the process of its digestion; and we require a powerful muscle—the heart—to circulate the blood through the body by the alternate contraction of its several chambers; while powerful muscles of respiration alternately fill and empty the lungs.

Now, the first point I would lay stress upon is, that all these actions are essentially and originally automatic. When I say originally, I mean from the very beginning—from the moment when the child comes into the world, or even before. We know that the first thing the new-born infant does is to draw a long breath; and from that time breathing never ceases,—the cessation of breathing being the cessation of life. The heart's action has been going on for months before birth; and its entire suspension for a very short time, whether before or after birth, would bring the whole vital activity of the body to an end.

These motions are executed by the nervo-muscular apparatus, in a way that does not involve our consciousness at all. We do not even know of our heart's action unless it be very violent, or we be in such a position that we feel it knocking against our side. But still it is going on regularly and tranquilly, though it may not be felt from one day's end to another. We cannot stop it, if we would, by any effort of the will; but it is affected by our emotional states.

So, again, we do not know that we are breathing, unless we attend to it. The moment that we direct our attention to it, we become aware of the fact; but if we are studying

closely, or listening to a discourse, or attending to some piece of music, or, indeed, doing anything that engages our consciousness, we are no more aware of our breathing than we are during sleep. This shews you, then, that when breathing goes on regularly the action is purely automatic. But we have a very considerable control over our muscles of respiration. If my respiratory movements were as purely automatic as those of an insect, I could not be addressing you to-night; because the whole act of speech depends upon the regulation of those movements. We must have such power over the muscles, as to be able to breathe forth successive jets, as it were, of air, which, by the apparatus of articulation, are converted into sounding words. Though we have power over the respiratory organs to a certain extent, we cannot "hold our breath" many seconds. In the West Indies the overworked negroes used formerly to try to commit suicide by holding their breath, but could not do it, except by doubling their tongues back so as to stop the aperture of the glottis; for the impulse and necessity for breathing became so imperative, that they could no longer resist the tendency to draw in a breath. Thus, whilst we have a certain voluntary control over this act of breathing, so as to be enabled to regulate it to our purposes, we cannot suspend its automatic performance long enough to interfere seriously with the aeration of the blood.

Let me briefly notice some of our other automatic actions. In the act of swallowing, which properly begins at the back of the throat, the "swallow" lays hold of the food or the drink brought to it by the muscles of the mouth, and carries this down into the stomach. We are quite unconscious of its passage thither, unless we have taken a larger morsel or something hotter or colder than ordinary. This is an instance of purely automatic action. If you carry a feather, for instance, a little way down into the "swallow," it is laid hold of and carried down involuntarily, unless drawn back with your fingers.

Take as another instance, the act of coughing. What does that proceed from? You may have allowed a drop of water or a crumb of bread to "go the wrong way," and get into the air-passages. It has no business there, and will excite a cough. This consists, in the first place, in the

closure of the glottis—the narrow fissure which gives passage to the air—and then in a sort of convulsive action of the expiratory muscles, which sends a blast of air through the aperture, that serves to carry away the offending substance. Nothing can be more purpose-like than that action, yet it is purely automatic. You cannot help it. You may try to stifle a cough for the sake of the audience or the lecturer, but the impulse is too strong for you. You see, then, the purely involuntary nature of this action. The person who feels inclined to cough may endeavour to overcome the automatic tendency by an effort of his will. He may succeed to a certain degree, but cannot always do so.

Now, although we cannot voluntarily stifle a cough when it is strongly excited, we can cough voluntarily, with no excitement at all. You can cough, if you choose, to interrupt the lecturer, as in the House of Commons coughing is sometimes used to put down a troublesome speaker; and little coughs are sometimes got up to give signals to some friend privately. Or, again, the lecturer, who may feel his voice husky in consequence of some little mucus in his throat, wishes to clear it away; its presence does not excite the movement, but he coughs intentionally to get rid of it. Now, I would have you fix your attention on these two points: in the first place, coughing as an involuntary movement excited by a stimulus in the throat; and in the second place, as a voluntary movement executed by a determinate effort. This distinction is the key to the whole study of the nature of the relation between the mind of man and his muscular apparatus.

The automatic movements of which I have been speaking depend upon a certain part of the nervous centres, which does not enter into the structure of the brain properly so called; namely, the *medulla oblongata*, or the upward prolongation of the spinal marrow—the spinal cord, as physiologists call it—into the skull (*a*, figs. 1, 2).

The effect of the stimulus or irritation in the windpipe may not be felt as tickling; for coughing will take place in a state of profound insensibility. An impression is made upon the nerves which go to the *medulla oblongata*, and in that centre excites a change. It is the fashion now to call

this change a "movement of molecules;" but it is nothing more than a name for the action excited there, of the nature of which we know very little. I do not think that this expression is really very much better than the old doctrine of "vibrations" put forth by Hartley more than a century ago. The change thus excited produces a converse action in the motor nerves which go to the muscles, and thus calls forth the combined muscular movement of which I have spoken. This is a typical example of what the physiologist terms "reflex action."

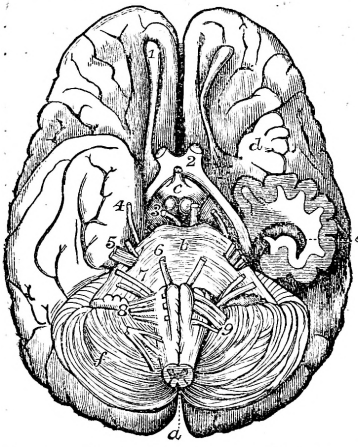

Fig. 1.—Under Surface of Brain.—*a*. Medulla oblongata, cut off from the spinal cord; *b*, pons varolii; *c*, infundibulum; *d*, portion of the convoluted surface of the cerebrum; *e*, portion of the same laid open, shewing the difference between the grey or ganglionic substance of the convolutions, and the white or fibrous substance; *f*, cerebellum; 1, olfactory ganglion; 2, optic nerves; 3–9, successive cranial nerves.

The whole Spinal Cord is a centre of "reflex action," in virtue of the grey or ganglionic matter it contains, in addition to the white strands which form the connection between the spinal nerves and the brain; and this grey matter is present in different parts of the cord in different amounts, in proportion to the size of the nerves connected with each. Each ordinary spinal nerve contains both sensory and motor fibres, bound up in the same trunk, but these are separate at its roots (fig. 3); and a part of each set of fibres has its centre in the grey matter of the spinal cord itself, whilst another part is continued into its white strands. Although, however, we speak of "sensory" fibres, we do not mean that impressions on them always call forth sensations. For in the case of many involuntary acts, a certain impression is made on the sensory nerve,

and a reflex influence excited by this acts through the corresponding motor nerve without calling forth any sensation. An impression is conveyed towards the ganglionic centre, which possesses a power of *reflexion*—not reflection in the mental sense, but in the optical sense of the reflection of rays from a mirror. If we break any part of this "nervous circle," as Sir Charles Bell called it, its action is destroyed. Cut the sensory nerves, and no reflex action can be excited. Cut the motor nerves, and no muscular contraction can be called forth. Destroy the centre, and you will not have the reflexion. The complete nervous circle is necessary for the performance of every one of these reflex actions.

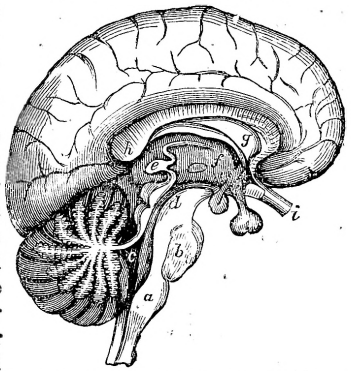

Fig. 2.—VERTICAL SECTION OF BRAIN THROUGH ITS MIDDLE PLANE; shewing the relation of the Cerebrum A and the Cerebellum B, to the Sensori-motor Tract, which may be considered as the upward extension of the medulla oblongata, *a*, and includes the parts lettered *d*, *e*, *f*; at *h* is shewn in section the corpus callosum, or great transverse commissure uniting the two cerebral hemispheres; and at *g* the longitudinal commissure, connecting the front and back parts of each; *i*, optic nerve.

What I want first to impress upon you is, that the reflex movements immediately concerned in the maintenance of Organic life all take place through this lower portion of the nervous system, which has no necessary connection with either sensation or will. That is to say, that if there were no higher part of the nervous system than the spinal cord, we should still have reflex action without the Ego having anything to do with it.

I may illustrate this by the act of sucking, which involves a curious combination of respiratory movements with movements of the lips. This act can be performed without any brain at all; for infants have come into the world without the brain, properly so-called—with nothing higher than

the prolongation of the spinal cord — and have sucked, breathed, and even cried for some hours; and all the true brain has been removed experimentally from new-born puppies, which still sucked at the finger when moistened with milk and put between their lips. This shews how purely automatic these actions are.

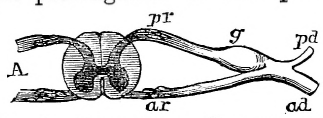

Fig. 3.—TRANSVERSE SECTION OF SPINAL CORD; shewing its grey or ganglionic core, enclosed in its white strands; *a*, *r*, anterior or motor roots; *p*, *r*, posterior or sensory roots.

But we now come to that other class of movements—namely, those properly belonging to the apparatus of Animal life—which are concerned in the obtaining of food and in carrying on ordinary locomotion. I have to shew you to what a large extent, among some of the lower animals, these movements are originally automatic; and, on the other hand, to inquire into their nature in Man.

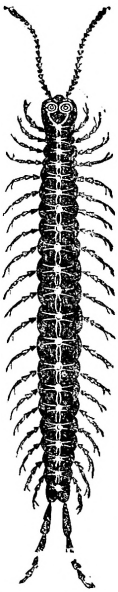

Fig. 4.—GANGLIATED NERVOUS CORD OF CENTIPEDE.

We will go to the class of Insects and their allies the Centipedes, as giving the best illustration of the primary automatic movements of animal life. Here (fig. 4) is a diagram of a Centipede. Every child who has dug in the ground knows the "hundred-legs," and is pretty sure to have chopped one in two, and noticed that each half continues to run. This is in virtue of the ganglion existing in every joint of the body, which is the centre of the reflex action of the legs belonging to it, and which keeps each joint in motion even after it is separated from the body. If one of these creatures is cut into half a dozen pieces, every one of them will continue to run along. But, again, if we divide the nervous cord which connects the ganglia, the sight of an obstacle may cause the animal to stop the movement of its fore legs, yet the hind legs will continue to push it on. If you take out the middle portion of the chain of ganglia, the legs of that

part will not move; but the legs of the front part will move or not, according to the direction of the ganglia of the head, which seem to control the action of the other ganglia in virtue of their connection with the eyes; and the legs of the hind part will continue to move as before.

When one of these creatures goes out of the way of an object before it, we may assume that it sees the object; for although we have no absolute proof that insects do see anything, I cannot see that there is any disproof of a conclusion to which all analogy points. Certainly it seems to me that if I try to catch a fly, and if it jumps or flies away, or if I go out and try to catch a butterfly with a net, and it flies off, it does so because it *sees* the net. Those who have watched bees, when a storm is coming on, flying straight down from many yards' distance to the entrance of the hive, can scarcely help concluding that they *see* the entrance. At any rate, it is not proved that they do not.

Well, then, the Centipede avoids an obstacle. A visual impression is made on the eyes, and by their agency is communicated to the large ganglia in the head; the reflex action of which controls that of the other ganglia, and *directs* the movement of the body.

We find that the size of these cephalic ganglia in flying Insects has a very close relation to the development of their eyes; the eyes being most highly developed in the most active insects, and the ganglia connected with them the largest; while the general movements of these insects are most obviously guided by their sight. Here is a clear case of original or primary automatism; because these actions are all performed by the insect almost immediately that it comes forth from the chrysalis or pupa state; as soon as its wings have dried, it begins to fly; and obviously sees and avoids obstacles just as well as if it had been practising these movements all its life.

Then, in the case of Insects, we notice that very remarkable uniformity of action, which we characterise as "instinctive." They execute most remarkable constructions after a certain plan or pattern, with such extraordinary uniformity and absence of guidance from experience, that we infer that they must have inherent in them a tendency to perform those actions.

We see this in the case of hive bees, which are distinguished for their elaborate architecture, and for their remarkable domestic economy. I do not say that there is no rationality in insects, and that there is nothing done with conception and purpose; because some of their actions seem to indicate this, especially those which are described in recent accounts of ants given by Mr. Belt in his "Naturalist in Nicaragua." Sir John Lubbock's experiments also certainly do seem to indicate a power of adaptation to changes of circumstances that were not likely to have frequently occurred naturally in the history of the race, so as to have become habitual—changes brought about by human agency, so foreign to the ordinary habits and instincts of the creatures, that we can scarcely attribute their consequent action to anything but a conscious adaptation to these ends. But this is a matter to be still cleared up—how far experience modifies the actions of insects. As a general fact, I may say that they carry Automatism to its very highest extreme.

To give another illustration—the *Mantis religiosa* (fig. 5), an insect which is allied to the crickets and grasshoppers, but which does not habitually either jump or fly. It is a very savage insect, and lies in wait for its prey like a tiger. You can see the curious form of the long fore-legs, which act as arms, and are waved about in the air; and it rests on the two hinder pairs of legs. Now, observe that the front pair are supported upon a very long first segment of the thorax; the two other segments bearing the wings and the two other pairs of legs. Each of these divisions has a ganglion, which is the centre of the movements of the limbs attached to it. The insect is always

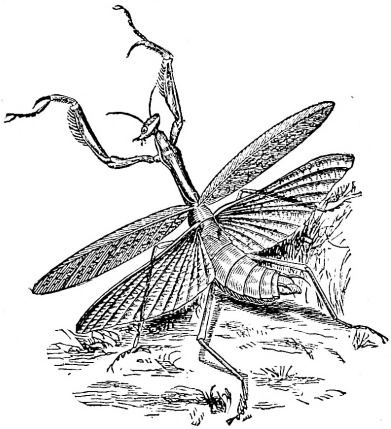

Fig. 5.—Mantis Religiosa.

lying in wait; and if any unlucky insect comes sufficiently near, the arms close round it and dig-in a pair of hooks, with which the feet are furnished. By this act the unfortunate victim is soon put out of existence. Now if the head of this Mantis be cut off, the arms still go on moving about in the same way; and if anything is brought within their reach, they impress the hooks upon whatever they grasp. The eyes simply direct their action, the action itself being dependent on the ganglion from which the nerves of these members proceed. Further, if we cut off that division and separate it from the hind part of the body, the same thing will go on. If anything is put within its grasp, the arms close round it and impress the hooks with just the same automatic action as we see in the Venus's fly-trap. Not only this, but if you try to upset the body, it will recover its balance, and rise again upon the hind legs.

This shews you how completely automatic the movements are. The name of *Mantis religiosa* is derived from the curious attitude in which this insect habitually lives—as if raising its arms in prayer. We have not this insect in Great Britain; but the French call it the *Prie Dieu*, which is equivalent to *religiosa*.

We now come to the lower Vertebrate animals, of which we may take the Frog as the best illustration. Its Spinal

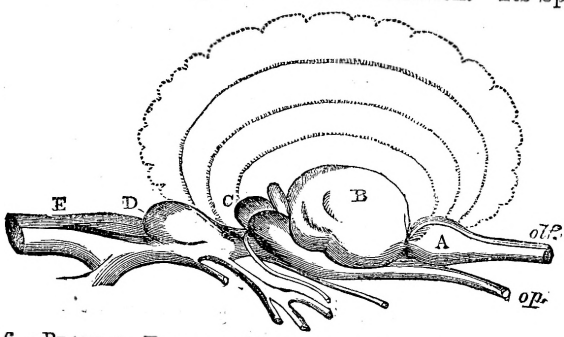

Fig. 6.—Brain of Turtle, with diagrammatic representation of the increased development of the Cerebrum in higher Vertebrata;—A, Olfactory ganglia; B, Cerebral hemispheres; C, Optic ganglia; D, Cerebellum; E, Spinal cord; *olf*, Olfactory nerve; *op*, Optic nerve.

Cord may be considered as the representative of the chain of ganglia in the centipede; the principal difference being that its ganglionic matter forms a continuous tract, instead of being broken up into distinct segments. But we find in the head, instead of the one pair of ganglia connected with the eyes, a series of ganglia connected with the several organs of sense, together with two masses of which we have no distinct representatives among the lower animals — namely, the *cerebrum* and the *cerebellum*. The relation of these to the other ganglionic centres is shewn in fig. 6, which represents the brain of the Turtle; A being the olfactive lobe, or ganglion of smell, from which proceed the olfactory nerves; B the cerebrum; C the optic lobe or ganglion of sight, from which proceed the optic nerves; D, the cerebellum; and E, the spinal cord. In most fishes the cerebrum is actually smaller than the optic lobes; but as we ascend in the series towards man, we find it becoming relatively larger and larger; so that it covers-in and hides the series

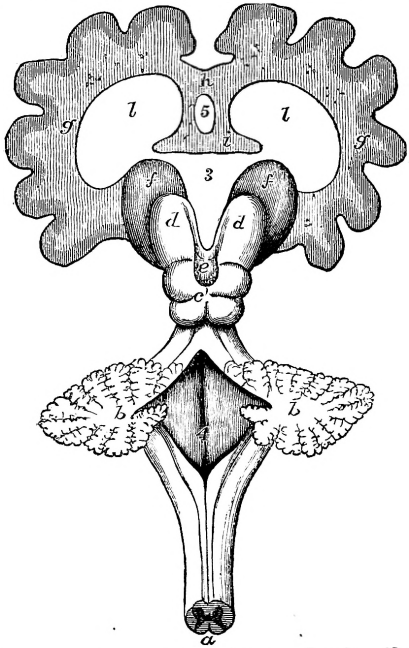

Fig. 7.—Diagram of Brain, shewing the relations of its principal parts:—*a*, spinal cord; *b*, *b*, cerebellum divided so as to lay open the fourth ventricle, 4, which separates it from the medulla oblongata; *c*, corpora quadrigemina; *d*, optic thalami; *f*, corpora striata, forming the sensori-motor tract; *g*, *g*, cerebral hemispheres; *h*, corpus callosum; *i*, fornix; *l*, *l*, lateral ventricles; 3, third ventricle; 5, fifth ventricle.

of ganglionic centres lying along the floor of the skull. These *sensori-motor ganglia*, (fig. 7, *c*, *d*, *f*), though commonly regarded as appendages to the cerebrum, really constitute the fundamental portion of the brain; they may be regarded as an upward continuation of the spinal cord; and I have been accustomed to designate this whole series of centres (excluding the cerebrum and cerebellum) as the *axial cord*. In this all the nerves of sense terminate, and from it all the nerves of motion arise, the cerebrum having only an indirect connection with either.

The proportional size of the Cerebrum in different animals, as compared with that of their axial cord, corresponds so closely with the manifestations of intelligence (that is, the *intentional* adaptation of means to ends, under the guidance of experience) as contrasted with blind unreasoning instinct, that there can be no doubt of its being the instrument of the reasoning faculty. The cerebrum attains its *maximum* size and complexity in Man; on the other hand, in the frog it is relatively much smaller than in the turtle; and it would seem that the actions of this animal are provided for almost entirely by the reflex power of its automatic apparatus—namely, the spinal cord with the ganglia of sense. Suppose that we divide the spinal cord in the middle of the back, between the fore legs and the hind legs, what happens? We find that the animal can no longer move the hind legs by any power of its own, but that they can be made to move by pinching the skin of the foot. If acid is put on one leg, the other will try to wipe it off; and a number of movements of that kind are called forth by stimuli of various kinds. Yet we feel justified in saying the frog does not feel them. We know, as a matter of experience, that if a man receives a severe injury to his back—as has happened very often in London, and also, I suppose, in Glasgow, among the shipping in the docks—through his striking some projecting object in falling, his legs are completely paralysed. He has no feeling in them, and no power of moving them. But after the first shock of the accident has passed off, if you tickle the soles of his feet, or apply a hot plate to them, the legs are drawn up. The man will tell you he feels nothing whatever, and would not know what had taken

place if he did not see the movement. A case of this kind occurred to the celebrated surgeon, John Hunter, who asked a man, "Do you feel this in your legs?" "No, sir," he replied, "but my legs do." That was not scientifically correct, because his legs could not be properly said to feel that of which the Ego was unconscious; but it expressed the fact that the irritation called forth a respondent motion.

There is only one other mode of explaining this action; namely, that by dividing the spinal cord we have made a second Ego—a new centre of sensation—in the lower part of the cord. In that case we make as many Egos in the centipede as we cut the body in pieces; and we might make three separate Egos in the frog—the head, the upper part of the trunk with the fore-legs, and the lower part with the hind legs, each acting independently. This seems to me inconceivable; I entirely go with those who maintain that these actions are provided for by a purely automatic mechanism.

A still more remarkable fact is, that if we remove the higher nervous centres, leaving only the Spinal Cord, and with it the Cerebellum (which appears to have the power of combining or co-ordinating the movements), we find that the general actions of locomotion are performed as in the uninjured animal. Thus the frog will continue to sit up in its natural position; and if we throw it into the water it will strike out with its limbs and swim, just as if the whole nervous system was intact. This is the case also with the *Dytiscus marginalis*, a water-beetle, which, when the ganglia of the head have been removed, will remain upon a hard substance without any movement; yet, if dropped into water, will begin to strike out, swimming in the usual way, but without any avoidance of obstacles. So the frog, if a stimulus is applied, will jump just as if the brain had been left. If put on the hand it sits there perfectly quiet, and would remain so unless stimulated to action; but if the hand be inclined very gently and slowly, so that the frog would naturally slip off, the creature's fore-feet are shifted on to the edge of the hand until he can just prevent himself from falling. If the turning of the hand be slowly continued, he mounts up with great care and deliberation, putting first one leg forward and then the other,

until he balances himself with perfect precision upon the edge; and if the turning of the hand is continued, over he goes through the opposite set of operations, until he comes to be seated in security upon the back of the hand. All this is done after the brain proper has been removed, shewing how completely automatic this action is. Another remarkable fact is, that if you stroke one particular part of the skin, the frog will croak.

Precisely parallel experiments were made by Flourens. By removing the brain of a Pigeon he found that the animal retained its position, and would fly when thrown into the air. If the optic ganglia were left, he found evidence that the animal either saw, or that its movements were guided by impressions received through its eyes. The head of the pigeon would move round and round if a light was moved round in front of the eyes. So in the frog it was found that, if the optic ganglia were left, it would avoid obstacles placed in front of it, when excited to jump.

Thus we see how completely automatic these movements are, and how entirely they are dependent on the reflex action of the axial cord, the Cerebrum not being necessary for their performance. The removal of that organ, however, seems to deprive the animal of all spontaneity; it remains at rest unless excited to move, and seems to do nothing with a purpose.

Let us now go to Man, and examine the nature of his movements. You have all seen a child learning to walk. You know that it does not get upon its legs to walk all at once, like a newly-dropped lamb; but that its muscles have to be trained, and this training is a very long process. The child learning to walk, as Paley says, is the greatest posture-master in the world. It requires a long course of experience to acquire the power of moving its limbs in a proper manner to execute the successive steps; but far more training is required in balancing. This balancing of the body is one of the most curious things in our mechanism. No automaton has ever been made to walk. I once saw an automaton that professed to walk; but it had only a gliding motion; and upon looking at the feet I found some concealed springs beneath, so that neither foot was ever really lifted.

The act of walking requires a continual shifting of the centre of gravity from side to side, so as to keep it over the base during every step; and it is this shifting from side to side, that constitutes the great difficulty in the act of walking. Almost every muscle in the body is in action in the maintenance of our balance and in the forward movement. The muscles of the eyes, even, are in operation in keeping our gaze fixed upon what is before us, and thus guiding our onward movement. But when this movement has been once acquired, it goes on unconsciously. If you are walking with a friend and engaged in earnest conversation, you may walk a mile and not be the least conscious all the time of your having been successively advancing one leg after another; and you do exactly the same thing while walking in a state of mental abstraction. So, again, you are guided by your sight, when you have once set out, along the line you are accustomed to take. I am in the habit of walking down the Regent's Park every lawful day, as you call it in Scotland, to my office at the University of London. I frequently fall into some train of thought—as lately about this lecture; and I follow on that train of thought, not only unconscious of the movements of my legs, but unaware of the directing action of my vision. Yet I know that my eyes have been directing me. When I have come into the crowded streets, I have not run against my fellow passengers, or knocked myself against a lamp-post. My legs have been moving the whole time, and have brought me to my destination, sometimes to my surprise. This must have been the experience of all of you who are accustomed frequently to walk along a certain line. It has even been the case that when you have set out with the intention of departing from your accustomed line, for some little business or other, and have fallen into a train of thought, through pre-formed association you keep in the habitual line. After getting half way down a street you suddenly find that you have not gone out of your way, as you intended to do. I regard such habitual action as purely automatic; not primarily, but *secondarily* automatic, the automatism not being original but *acquired*. This is the most universal of all forms of acquired automatic action

in Man—not only the motion of the limbs, but the direction of their movements by the sight.

The act of walking may become so automatic as to be performed during sleep. Soldiers fatigued by a long march continue to plod onward when sound asleep. If there are no obstacles they go steadily onwards, just like the centipede when its head has been cut off. The Indian punkah-pullers—men who are engaged the whole day pulling a string backwards and forwards, to move the great fan which produces a current of air in every room—often go on as well when they are asleep as when they are awake.

These are two instances of acquired automatism; and I might add a great many more, because everything that becomes habitual to a man is occasionally performed automatically in the state called absence of mind. Thus when a gentleman goes up to his dressing-room to dress for a party, the first thing he commonly does is to take out his watch and lay it on the table. The next thing he often does—I have done it myself—is to wind up his watch, as if he was retiring for the night. I have known a case in which the gentleman completed his undressing and then went to bed; so that when his wife came in search of him, he was comfortably resting from his day's work. That was a case of pure automatism; and I could relate many more instances of the same kind, but you must all have noticed such things in your own experience. A particular manual operation can be done, if it is one not requiring the constant direction of the mind, quite automatically. A man can plane a board, for instance, or work his loom, while his mind is entirely occupied in another direction. A musician will play a piece of music, and yet maintain a continuous conversation at the same time.

There is a very amusing and suggestive book which I recommend you to peruse, "The Autobiography of Robert Houdin, the Conjurer," who describes the training by which he prepared himself for the performance of various of his feats of dexterity. Amongst other things, he tells us that he devoted a great deal of time and attention in early life to the acquirement of the faculty of being able to read a book continuously, and at the same time to keep up balls in the air. He brought himself to be able to keep up four

balls in the air, without detaching his mind from his book for a moment. He could continue the train of thought that the book suggested, without giving his attention at all to the keeping up of the balls; this action being only a more elaborate form of the trained automatism that I have spoken of. The thought occurred to him, when writing his autobiography, that he would try whether, after thirty years' cessation from this performance, he could still execute it. He stops, and then continues his memoir: "I have tried this, and find I can keep up three balls." There, I believe, the nervo-muscular combination that was required, had come by early training to be a part of his physical constitution, and had been kept up by nutrition. Whatever, in fact, we learn to do in the period of growth, we can continue to do without practice after the growth has been completed; whilst acquirements that we make subsequently are more easily lost when we are "out of practice." I think all experience shews that; and I believe it is for this physiological reason—that the bodily and mental constitution acquired during the period of growth becomes "a second nature," and is maintained throughout life; whilst any modification it may undergo afterwards is something superadded to that basis, and is the first to decline when the habit of action ceases.

We now pass to the other part of our subject—the relation between the higher part of our nature, the Ego, and these automatic actions. What I shall endeavour to shew you very briefly is this, that the whole of the nervo-muscular apparatus concerned in executing the mandates of the mind acts as a trained automaton. Anything which we mentally determine to do "we will," as we say. In using the word "will" I do not mean a separate faculty, I mean the Ego in a state of action. The Ego determines to do a certain action, and commands the automaton to do it. The will does not, as physiologists used to believe, throw itself into a particular set of muscles; but says to the automaton, "do this," and it does it. There are many things which the Ego desires to do, but which he cannot make the automaton do for want of training. For instance, many of you may strongly desire to be able to play a musical instrument. You may be able to read the music, and by watching

a performer may see precisely how to do it, but you cannot do it, simply for want of training. The same is the case with a great many other actions which we can only acquire by practice. Again, you may wish to do something physically impossible. The Ego may earnestly desire and intend to make some great effort—to take a great leap, for instance, to save his life. He may will to hang on to a cord as long as may be necessary to prevent his falling from a height. The Ego wills this with all his energy; but his muscles will not obey him, because it is not in their nature to maintain their tension for longer than a certain period.

Let me give you a little experiment that I think every one will find instruction in performing on himself; it occurred to me while lecturing on physiology as suited to conduct my students exactly to the idea I wished to impress upon them. There happened to be a bust opposite me, and I said, "Now, I will to look at that bust, and I will at the same time to move my head from side to side." I told them to watch my eyes, and they could all see them rolling from side to side in their sockets,—as you can see for yourselves by looking at your own eyes in a looking-glass, and turning your head from side to side. You do not feel that you are using the slightest exertion, and would not be aware of the motion of your eyes unless you knew it as a matter of fact, or some one else told you that you were doing so. You have said to your automaton, "Look at it" (whatever it may be), and at the same time "move your head round;" and the automaton rolls its eyes in the contrary direction, and thus keeps the image on the same part of the retina.

That is what I maintain to be the general doctrine of the automatism of the body, directed and controlled by the will;—the Ego willing the result, and leaving it to the automaton to work it out; as when I set my automaton to walk to a certain place, and direct my thoughts to something altogether different.

We have now, in the last place, to consider how far the Mind of man acts automatically. This is a subject confessedly of very great difficulty. There are those who consider that the mind of man is essentially and entirely dependent upon his bodily organisation, although they may

still hold the separate existence of the mind. They find it, indeed, very difficult to conceive that there can be anything else than automatic action; because they see to what a very large extent our mental activity is conditioned by the physical constitution of the body.

The Physiologist can have no more doubt that there is a mechanism of thought and feeling, of intellect and imagination, of which the Cerebrum is the instrument, than that there is a mechanism of instinct of which the Axial Cord is the instrument. When one idea suggests a second, in accordance with a preformed association, the second a third, and so on, constituting what we call a "train of thought," without any order from ourselves, we seem fully justified by a large body of evidence in affirming that this is the mental expression of a succession of automatic changes, each causing the next, in the ganglionic matter which forms the convoluted surface-layer of the Cerebrum. These changes may or may not result in bodily motion. What we call the "movements of expression," are the involuntary signs of the state of our feelings; and so the movements executed by sleep-walkers are the expressions of the ideas with which their minds are possessed. So great talkers, like Coleridge, sometimes run on automatically, when they have got patient listeners; one subject suggesting another, with no more exertion or direction of the will than we use in walking along a course that has become habitual. All this may be regarded, physiologically, as the "reflex action of the cerebrum," the physical mechanism of which is partly shaped by its inherited constitution, and partly by the training to which it has been subjected, whether by intentional education, or by the education of circumstances—the brain "growing to" the mode in which it is habitually worked, just as the mechanism of our bodily movement shapes itself to the work we habitually call on it to perform. We constantly see that mental faculties are inherited, as well as bodily powers; that children brought up after the parents' death, shew most remarkably the mental tendencies of one or both of them. They do a number of things in exactly the same manner that the parent did, have the same moral and intellectual tendencies, and present an extraordinarily striking resemblance in general character.

This principle of the hereditary transmission of faculties through the physical organisation is now generally admitted; and what is more, I think it is clear that many of these faculties and tendencies have been acquired and superinduced, as it were, in the constitution of the parent, upon what it originally possessed. There is one very remarkable and too common example of this hereditary transmission, namely, the tendency to alcoholic excess. I remember a friend telling me he had known a man who for forty years got up every morning with the strong apprehension of being unable to resist that craving, which was an essential and inherent part of his nature, inherited from the unhappy indulgence of his father. That man fought a most heroic fight every day of his life. Every now and then he fell, but recovered himself; and, to my mind, fall as he did, his recovery shewed him to possess a far higher moral nature than that of the man who never yields because he is never tempted. I cite this merely as one example of acquired tendency hereditarily transmitted; all of us are familiar with cases more or less resembling it.

But the question is, whether the Ego is completely under the necessary domination of his original or inherited tendencies, modified by subsequent education; or whether he possesses within himself any power of directing and controlling these tendencies? It is urged by some that as the physical structure of his Cerebrum at any one moment is the resultant of its whole previous activity, so its reflex action, determined by that physical structure, must be really *automatic;* the only difference between a *voluntary* or *rational*, and an *involuntary* or *instinctive* action, lying in the complexity of the antecedent conditions in the former case, as distinguished from their simplicity in the latter. And it is held, in like manner, by many who look at the question from the mental side, and who do not trouble themselves at all about the physiological aspect of it, that a man cannot act in any other way than in accordance with his character; and that his character at any one moment is the general resultant of his whole previous mental life. But even John Stuart Mill, the most able and conspicuous advocate of this doctrine, felt that in making every man entirely dependent upon his in-

herited constitution, and his subsequent "circumstances," it excluded all possibility of real *self*-direction, all hope of *self*-improvement; and this, he tells us in his autobiography, weighed on his existence like an incubus. "I felt," he says, "as if I was scientifically proved to be the helpless slave of antecedent circumstances, as if my character and that of all others had been formed for us by agencies beyond our control, and was wholly out of our own power." The way out of this darkness he found in what seems to have struck him as a new discovery, although it was familiar enough to many who had previously studied the action of the mind,—"that we have real power over the formation of our own character; that our will, by influencing some of our circumstances, can modify our future habits or capacities of willing."

Now, this I hold to be accordant with the experience of every one who has thought and observed, without troubling himself with philosophical theories. We all perceive that in the earlier period of our lives, our characters have been formed *for* us, rather than *by* us. But we also recognise the fact, that there comes a time when each Ego may take in hand the formation of his own character; and that it thenceforth depends mainly upon *himself* what course its development shall take,—the most valuable result of early training being that which prepares him to be *his own master*, keeping in subjection his lower appetites and passions, and giving the most favourable direction to the exercise of his higher faculties. And I shall now explain to you what seems to me the process by which this is effected.

Every one knows that he can determinately *fix his attention* upon some one object of sense, to the more or less complete exclusion of all others. In looking at a picture, for instance, he can examine each part of it separately; or, if he has a "musical ear," he can single out any one instrument in an orchestra, and follow it through its whole performance. Now, just in the same manner we can fix our attention upon one state of consciousness (a thought or feeling) to the exclusion of others. Supposing that you are endeavouring to fix your mind upon a certain object of study, or are reading a book that requires much

thought to follow it, or are trying to master a mathematical problem, or are desiring to work out a certain question as to the conduct of your own lives, and you are attracted by the coming-in of a book or a newspaper which you would like to look at, or are distracted by noises or the playing of a musical instrument, you feel that it is in your power to fix and maintain your attention by a sufficient effort. That determinate effort is what we call an act of the will; and I believe that the power of so fixing our attention is the source of all that is highest and best in our intellectual self-education, as, in another direction, it is the source of all our moral self-improvement.

The automatist will say that your doing so is merely the result of the preponderance of one motive over the other,—the desire to go on with your study being stronger than the attractive or distracting influence. But if this be the whole account of the matter, why should we have to "make an effort,"—to struggle against that influence? We choose, as it seems to me, which is the thing that we deem preferable; and we then throw the force of the Ego into the doing of it, just like a man who makes a powerful muscular exertion to free himself from some restraint. And I hold that just as the Ego can turn to his own account the automatic action of his nervo-muscular apparatus, regulating and directing his bodily movements, so he can turn to his own account the automatic activity of his cerebrum, regulating and directing the succession of his thoughts, the play of his emotions. That succession is in itself automatic; you cannot produce anything, otherwise than by utilising what may spontaneously present itself; and you do so by the *selective attention* of which I have spoken, intensifying your mental gaze so as to make the object before you call up some other, until you get what you are seeking for. This you may readily trace out for yourselves if you will observe your own mental experiences, in trying to recollect something. And what shews the essentially automatic action of the cerebral mechanism in this familiar operation, is that after you have been for some time trying in vain to recall some forgotten name or some recent occurrence which has "escaped your memory," it will often flash into your mind

some little time afterwards, when you have turned your attention to something else. In the same manner many important inventious and discoveries have proceeded from the automatic working of the Cerebrum, set going in the first place by the determinate fixation of the attention on the object to be attained; the success of the result being due to the whole previous "training" of the organ.

The act of fixing the attention, in my belief, lies at the foundation of all education, and is one to be fostered and encouraged in every child. It is better to begin with only a few minutes at a time; gradually, by encouragement, the child comes to feel that it has a power of its own to prolong its attention; and at last the encouragement is no longer needed, for the child that has been judiciously trained will exert all its determination to learn its lesson, in spite of temptations to go out and play or to amuse itself in any other mode. But if this determination were simply the expression of a preponderance of motive, I do not see why an *effort* should have to be made. If the motive to fix the attention be stronger than the attraction of any other object, or the prospective influence of the good to be gained be more powerful than the distracting influence, the mere preponderance of the one over the other would produce the result. But we know and feel that the making such a determinate effort, involves more expenditure, "takes more out of you," than the continuous sustained attention when there is no distracting influence; therefore, I say there is something here beyond the automatic preponderance of motive—the mark and measure of the independent exertion of the will.

Now this power, call it what we may, is capable of being strengthened by exercise—no power more so; neglected children being generally most deficient in it, and most carried away by their own impulses. No doubt a greater power of concentration is natural to some, and a greater mobility to others. But still I believe there is no healthy mind in which this power is not capable of being developed by training, just like the power of the limbs in walking. Its possession is the foundation of all intellectual discipline; without it we can do nothing good in intellectual study.

Look, now, at the moral side, and see how it operates

there. We begin by saying, "I ought not" to do so and so,—assuming a moral standard. Take the case, which is unfortunately so common a one, of a man who has a strong temptation to alcoholic indulgence. He knows perfectly well that an habitual yielding to that temptation will be his ruin. I have heard of a man who said that if a glass of spirits was put before him, and he knew that the pit of hell was yawning between, he *must* take it. This is an instance of the overpowering attraction it has for some individuals; but this generally results from habit; and it is over *the formation of habits* that the will can exert its greatest power, by fixing the attention on one set of motives to the exclusion of other motives. I do not say that a man can *bring* motives before his mind. He cannot do that—we can only take what comes into our minds; but he can direct his thoughts in a certain line, as it were, so as to find them. He can think of his family or the future, and so exclusively fix his attention on the consequences, as to withdraw it from the immediate attraction. That I take to be the best mode. A struggle goes on in the mind of many a man subject to temptation; but if he has strength of principle enough to resist the immediate tendency to wrong action, and so gets time to deliberate, he may thus nerve himself for the conflict. Many good resolutions are formed—we know what place is said to be paved with them—and we hope to realise them. We determine in ourselves that we will avoid particular indulgences. We may have some strong disposition to apply our powers to ill uses, to play some mean trick, or something of that kind. Most of us have temptations of self-interest—not less strong because not pecuniary,—as to gain credit that does not belong to us, and so on. We hold back—"pull ourselves together" is the phrase of the present time—and summon all our resolution and determination not to yield. There is something more, here, than mere preponderance of motive; for we determinately direct our attention to the reasons why we should or should not do the particular act. I believe that in such cases the mind is best withdrawn from the temptation, by *fixing the attention upon something else.* That is the real secret of victory. By fixing our mind upon the object, and saying "I won't do it." the temptation still

keeps haunting us. I have known many a struggle of this kind relieved by the determination to follow an entirely different course. We know that in cases of insanity, where a man is led by physical disorder to take a miserable view of everything relating to himself, the medical man sends him abroad, where he is attracted by a new set of objects —something which prevents his mind from brooding over his gloomy thoughts; and in that way, as his physical health improves, the man comes to feel that he can voluntarily transfer his attention from them to objects of interest round him. This, I believe, is the manner in which we should distract our minds from anything we feel and know to be unworthy of our attention;—we should find out something more worthy, and pursue it with determination.

I ask you to take as your guiding star, as it were, in the conduct of your lives, these four words—"I am," "I ought," "I can," "I will."—"I am" is the expression of reflection and self-consciousness, the looking-in upon our own trains of thought. If we do not feel "*I am*," we do not think of ourselves and our own nature—we surrender ourselves. "*I ought*"—expresses the sense of moral obligation. By steadily fixing our attention on the "I ought," the course of action is first directed right, and its continuance in that path becomes habitual. "Turn to the right and keep straight on," and you will find the doing so easy in proportion. Every right act, every struggle of the will against wrong, is the exercise of a power which strengthens with use, and will make the next act easier to you. On the other hand, every time you surrender your will to the temptations of self-interest, or sensual gratification, or anything that turns you from the straight path, there is a loss of power which makes the next effort more difficult. Then, "*I can*"—the consciousness of power, is the foundation of all effort. And, lastly, it is not enough to say, "I ought to do it, and I can do it," but we must *will* to do it. The "I AM," "I OUGHT," "I CAN," "I WILL," of the Ego, can train the mental as well as the bodily Automaton, and make it do anything it is capable of executing.