THE NERVOUS SYSTEM

AND

THE MIND

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A TREATISE ON THE DYNAMICS OF THE HUMAN ORGANISM

BY

CHARLES MERCIER, M.B.

'Without system the field of Nature would be a pathless wilderness.

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TO

DR. HUGHLINGS-JACKSON, F.R.S.,

TO WHOSE TEACHING IS DUE, DIRECTLY OR INDIRECTLY,

ALL THAT IS OF VALUE IN THIS WORK,

It is Dedicated

BY HIS ATTACHED FRIEND AND QUONDAM PUPIL

THE AUTHOR

PREFACE

THERE are few new facts in this book. It is an attempt, not to add to the number of observed facts, but to organise into knowledge those that we already possess. An isolated fact is as valueless as a stone in a meadow. Combined with other facts it forms a portion of the great fabric of Knowledge. My aim has been rather to build than to gather, and in building I have sought before all things to preserve the sacred character of the structure by using material unhewn, so letting the structure take the form imposed upon it by its components, and not shaping the facts to fit the fabric. All who know their writings will recognise that the foundations of this work are built on the ground prepared by Mr. Herbert Spencer, and that some of the plans have been adapted from Dr. Hughlings-Jackson. If I do not attribute to these masters a larger share in the design, it is for fear of fixing on them an unmerited responsibility for the stability of the edifice.

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INTRODUCTION

Not very many years ago, courses of lectures on Physiology used to be prefaced by an apology from the lecturer for occupying the time of the students with a subject which did not directly concern the treatment of patients, and by a laboured exposition of the various uses of a knowledge of physiology. Such an apology would not now be either needed or tolerated. The least intelligent of men needs now no explanation to convince him of the necessity of a knowledge of the normal as preliminary to a knowledge of the abnormal. The rawest of students requires no proof to show him that he cannot understand disorder of a function until he has some knowledge of its healthy working. Physiology is no longer considered a useless subject arbitrarily added to the medical curriculum by tyrannical examiners for the mere purpose of increasing the burden to be borne by students. So far we congratulate ourselves on a distinct advance of opinion. But the advance is not yet quite far enough. One branch of medical science has remained in this respect absolutely stationary. There is one department of medicine, and only one, in which a knowledge of the normal is not only not considered as a necessary preliminary to a knowledge of the abnormal, but is openly scoffed at, jeered at and derided.

To find a physician who ignored the anatomy of the nervous system in investigating tumours of the brain, or a surgeon who ignored the circulation of the blood in planning an operation, or an obstetrician who scouted a knowledge of the shape of the pelvis in conducting a difficult labour, would be impossible. But it is still possible and very frequent to find physicians engaged in the treatment of insanity, who regard the acquisition of a knowledge of the normal mind as a useless waste of time, and indeed as a pernicious dereliction of duty.

It seems reasonable to attribute to this neglect of the study of the normal, that complete absence of advance in the knowledge of insanity, which is so strikingly in contrast with the enormous strides that have been made in every other department of medicine. While in the last thirty years a score of specialties have branched out from the parent stock, and every specialty can show its brilliant record of discoveries in knowledge and of triumphs in treatment, the knowledge and the treatment of insanity have scarcely advanced since the days of Conolly.

In endeavouring to formulate the fundamental principles of a science of Alienism, I found myself continually interrupted by the necessity of interposing parenthetically a statement of the normal processes whose disorder it is that constitutes insanity. And as the work went on, the interruptions became so frequent and so prolonged as to destroy the continuity of the statement and to render evident the necessity of first providing an exposition of the normal as a chart on which the aberrations of the morbid could be picked out. Hence the present volume.

No doubt the main reason why the study of the normal mind has been disregarded by alienists is that the classical works on Mind ignore altogether its association with body, and study it from a standpoint so purely introspective as to offer no obvious advantage to the alienist, to whom the concomitant disorders of body are so conspicuous and so important. It is the absence of any statement of psychological doctrines in which the phenomena of mind are associated with the phenomena of nervous action and of conduct, which has rendered it in my view absolutely necessary to prepare such a statement before any appreciable advance in the science of insanity can be made. And in setting down these doctrines from the point of view and for the purposes primarily of the alienist, new principles and new aspects of old principles have come into view, which will, I trust, render the statement of them not only important to the alienist, but interesting also to the general student of psychology.

While, on the one hand, students of insanity are open to the grave reproach of neglecting altogether the study of the normal mind, students of mind, on the other hand, are almost equally open to the reproach of neglecting the study of nervous action. In their case, however, the corresponding palliation holds good in even a greater degree; for while a knowledge of mind is very obviously desirable in a student of insanity, the psychologist may easily be pardoned for failing to recognise that any light can be thrown on his science by a study of the anatomy of the cerebral convolutions, or by mastering the details of the microscopic structure of cells and fibres, of which works on Neurology are so largely made up. And while the overshadowing authority of John Stuart Mill has justified psychologists in abstaining from neurological study, the attention given by the neurologist to the mere structure of the nervous system, to the exclusion of its function, has gone far to confirm his brethren of the complementary science in disregarding his labours. Great as have been the advances in our knowledge of localisation of functions in the great nervous masses, these advances have hitherto been in the main anatomical,—that is to say, while we have arrived at a fairly complete knowledge of what part of the brain is put in action for the production of a particular movement of a limb, we have given no explanation of *how* it is that action of any part of the brain can produce a movement. This is the problem that seems most urgently in need of solution, not only from the point of view of the psychologist and alienist, but from that of the physiologist also; and, until a satisfactory solution is found, no further advance in neurology nor in the neurological aspects of psychology and alienism can be expected.

Since every one nowadays admits that the evolution of mind and the evolution of the nervous system have proceeded *pari passu*, and indeed are but two aspects of the same process, it would seem superfluous to offer arguments in favour of the correlated study of both, were it not that this way of studying them is so greatly neglected—is, indeed, as I have said, derided and scouted; and were it not that on the many occasions on which, during the last ten years, I have urged this mode of study on my brother alienists, I have been as the voice of one crying in the wilderness.[1]

The stock objection made to the study of Mind by alienists is that it is metaphysical and unpractical. As to the practical value of the study the remainder of this book must be my argument; but as to its metaphysical character, I would ask whether by metaphysics is meant anything more than an abstract and uninteresting subject. The popular idea of metaphysicians is that they are people who envelop themselves in a cloud of meaningless words,—that they are, as Burton says, "mad themselves, and wish to make others so," and that their works are a farrago of transcendental nonsense. That is a mistake. If a person ignorant of chemistry were to open a treatise upon compound radicals, he would find it unintelligible; but he

[1] As these sheets are going to press, the President of the Section of Psychological Medicine in the British Medical Association is advocating the view here set forth.

would not on that account stigmatise it as nonsense. He would attribute the unintelligibility to his own want of acquaintance with the meanings of the terms used. Why, then, should he consider a work on metaphysics nonsense because he is unable to gather clear ideas from its unfamiliar language? Mainly, I think, for this reason: that it deals with notions of a very highly abstract character. He can see that the book on Chemistry has a meaning, although he does not understand it; for the most cursory perusal shows him that it deals with concrete realities—with solids, fluids and gases, with acids and bases, with masses and molecules, forces and movements. But the work on metaphysics is not only written in unfamiliar language, not only deals with things which the general reader is unaccustomed to think about, but these things of which it treats are not concrete things that can be seen, handled and felt. They are qualities and relations always highly abstract, often very complex, and herein lies the difficulty of getting clear ideas about them. A person cannot assimilate highly abstract ideas merely by making a great effort and paying great attention to the words in which it is expressed, any more than he can play an air on the violin merely by taking the instrument into his hands and paying great attention to the music before him. Every one knows that in the latter case a long previous training and abundant practice are necessary before proficiency is attained, and the same is true in the former. And in this case as in that, proficiency can be reached only by a gradual progress from the less difficult to the more difficult instances. We know that an accomplished musician will take a printed sonata in his hands, and by reading it over will be able to form a clear mental image of the wilderness of sound that it represents; while to an ordinary person the page calls up no idea but that of black marks upon paper. May the latter therefore deny that the music book carries to any one else a more complete idea of the sounds than it gives to him? Surely not. Neither may the physician deny that metaphysical writings carry to others a clearer and more definite meaning than they convey to him. To say that mind should be studied without reference to metaphysics, is to say that the proper way to study mind is to ignore it.

It is not to be denied that there is a large amount of writing about the mind, and about the connection of the mind with the body, which is, strictly speaking, nonsense; but this writing is not metaphysical. Its authors repudiate the term with scorn. They are proud to boast of their ignorance of metaphysics. When I say that the writing is nonsense, I do not use this word as a term of vague abuse; it is used in its strict logical meaning to denote language which is not, alas, unfamiliar, but which is not only unintelligible but meaningless; it is used to connote language which has not, never had, and never can have, a meaning; and which is therefore strictly and truly nonsense. Such is the language used by those who speak of an idea producing a movement, or of a sensation passing along the nerves, or of pain causing the skin to sweat, or of the mind being a force, or of a nerve-current being transformed into a feeling, or of an idea being imprinted on the brain or stored up in the nerve-cells, or of will producing movements, or of any causal relation whatever between the events of Mind and the movements of Matter. Such propositions are neither correct nor erroneous—neither true nor false. They are nonsense; for when we try to bring their terms together, we find that we cannot assimilate them. We can think of each term separately, but we cannot bring them together in the relation expressed by the proposition, and it is easy to see that they never can be so brought together. Take an instance. Try to think of a feeling passing along a nerve.

We often speak familiarly of a toothache shooting along a nerve; is this an accurate expression? Take the nerve. Dissect it out. Lay it on the table before you. It is a gray thread, four inches long, made up of several fibres bound together. Now take a toothache and set it running along the nerve. You cannot. Why? It ran along the nerve, you said, when it was in the body; why cannot it do so now? Because, you will say, the nerve is no longer connected with the brain. Take another nerve, then, and do not separate it from the body; but pinch it, cut it, burn it or galvanise it. What torture! what excruciating agony! Surely this pain is in the nerve; you feel it there. Wait a little; let us consider. The nerve is made up of axis-cylinders and padding; in which is the pain? Certainly not in the padding; it must then be in the axis-cylinders. The axis-cylinders are gray threads of proteine substance, which is made up, like all other matter, of molecules swinging in space. Now, where is the pain? Is it in the molecules or in the intervening space? And how does it pass along the nerve? Does it jump from molecule to molecule, or does it flow in the interstices? If the former, pain must be a solid; if the latter, it must be a fluid; both of which hypotheses are manifestly nonsense. There is a third alternative. It may be a *movement* communicated from molecule to molecule, nay, surely it must be so, for every means that we have of producing pain—cutting, pinching, burning, striking, galvanising—is, when we consider it, a means of adding to the motion of the molecules of the nerves. Consider again. Imagine the molecules of the nerve swinging in space. Now imagine a wider swing. Does that resemble pain? Imagine a backward and forward swing changed into a circular movement. Does that resemble pain? Turn the circle into a spiral. Is that like pain? But it may be said, Pain, we know, is not really in the nerves, it is in the brain. Again the same problem awaits us. The brain is made of cells and fibres. Is pain in the cells? Is it in the fibres? In either case we must come down to molecules at last, and again the pain eludes our search. No conceivable form of matter and no conceivable movement of matter bears the smallest resemblance to pain, or can by any human imagination be assimilated to pain. We are driven to the conclusion that pain and matter are things with no community of nature, are facts of totally different orders, and cannot be reduced to any common term. Pain is neither in the nerves, nor in the brain, nor in any position in space. It is in the mind. Now, let us take another instance. Let us try to imagine an idea—say of food, producing a movement, say of carrying food to the mouth. The movement of the hand to the mouth is caused by the contraction of the muscles, and the contraction of the muscles is caused by the delivery into them of shocks from the nerves. The shocks carried by the nerves to the muscles are little waves of molecular movement that are set up by little explosions or rapid molecular decompositions of unstable matter—"gray matter"—at the central end of the nerve. This explosion or discharge is usually set up by the shock of some other discharge communicated from another region of gray matter, this by a third shock from a third region, and so on, until we come to a region that is directly affected by the shocks arriving along some "afferent" nerve, whose peripheral end is exposed to disturbances from outside the body. In the case supposed, the afferent nerve is the optic, and the shock that it transmits to the first region of gray matter is set up by the impact of ethereal waves upon its retinal expansion. Now at what stage of this process does the idea of food come in, and what is the method of its action? Does it assist the decomposition of the molecules of the gray matter, or does it retard the process, or does it alter the direction in which the shocks are distributed? Let us imagine the molecules of the gray matter combined in such a way that they will fall into simpler combinations on the impact of an incident force. Now, suppose the incident force, in the shape of a shock from some other centre, to impinge upon these molecules. By hypothesis, it will decompose them, and they will fall into the simpler combination. How is the idea of food to prevent this decomposition? Manifestly it can do so only by increasing the force which binds the molecules together. Good! Try to imagine the idea of a beef-steak binding two molecules together. It is impossible. Equally impossible is it to imagine a similar idea loosening the attractive force between two molecules. As for the third hypothesis—that the idea alters the direction of the nerve-currents, it can do so only by increasing the resistance in one direction or by diminishing it in another. It can increase the resistance to a wave of movement only by binding the molecules closer together; it can diminish it only by diminishing the attraction between them: and both modes of action are unimaginable, unthinkable, inconceivable. The idea of food is in the mind. It is an affair of consciousness. The movement of the hand is a material event. It is an affair of matter and force. Between the two there is, as far as we are able to perceive, no community of nature. "We do not possess the intellectual organ, nor apparently any rudiment of the organ, which would enable us to pass by a process of reasoning from the one to the other." What is true of pain and of the idea of food is true of every other feeling and of every other thought—of every other form of consciousness whatever; and the first, most important and most imperative, duty of the student of psychology is to recognise the impassable gulf, the fathomless abyss, that separates the world of consciousness from the world of material things.

Any expression which associates the facts of the one order with the facts of the other, in the manner in which they are associated in the sentences quoted at the beginning of this paragraph, is a meaningless expression, and must be unhesitatingly condemned.

Having thoroughly recognised the fathomless abyss that separates mind from matter, and having so blended the notion into his very nature, that there is no chance of his ever forgetting it, or failing to saturate with it all his meditations on the subject, the student of psychology has next to appreciate the association between these two orders of phenomena. While they are separated by a rift more complete than divides any other kinds of phenomena whatever, they are associated in a manner so intimate that some of the greatest thinkers consider them different aspects of the same process. These statements seem paradoxical, but they are not really difficult to comprehend. The gist of them is, that a state of mind never occurs as an isolated fact. When an alteration occurs in consciousness, something else always takes place at the same time. This inevitable accompaniment of mental change is a change in the nervous system; and the change is, speaking broadly, a re-arrangement of molecules in the gray matter of the superior regions of the nervous system. It has already been explained that a process of change in the nervous system cannot cause a change of consciousness; such an effect is unthinkable. Nor can a change in consciousness cause a change in the arrangement of the molecules of the gray matter; such an effect is equally unthinkable. The accepted doctrine is, that when the re-arrangement of molecules takes place in the higher regions of the brain, a change of consciousness simultaneously occurs. The two changes are concomitant. The change of consciousness never takes place without the change in the brain; the change in the brain never takes place under the same conditions without the change in consciousness. But why the two occur together, or what the link is which connects them, we do not know, and most authorities believe that we never shall and never can know.

Having firmly and tenaciously grasped these two notions, of the absolute separateness of mind and matter, and of the invariable concomitance of a mental change with a bodily change, the student will enter on the study of psychology with half his difficulties already surmounted.

While the distinction between mental and material events must never be ignored, forgotten or suffered to lapse, it is necessary to bear in mind that it cannot always be explicitly put forward. Our language grew into its present form before the distinction was recognised, and words cannot always be disentangled from the subsidiary meanings that have accumulated round them in the course of generations. New terms in which the distinction is ignored—such terms as "ideo-motor" and "pyscho-motor"—are to be rejected, repudiated and abhorred, as high treason to science—nay, as bordering on blasphemy. But it is impossible to strip away all the implications of material energy from such a term as Will. The Will has always been regarded as causing bodily movements, and no protest can now strip it of the power assigned to it; but when it is so regarded, it must never be forgotten that the word has a double meaning. It means first the state of mind that we call Volition or Willing; and it means secondly the nervous activity underlying that state of mind. And it is the nervous activity, and not the state of mind, that produces the bodily movement.

From what has been said, it will appear that the task before us includes the investigation of the facts of Consciousness, the description of the mode of working of the nervous system, and the examination of the conditions under which, the extent to which, and the manner in which the changes of the one accompany the operations of the other. But this is not all, nor is it even the chief part of the domain of psychology. The facts of Consciousness can be known only in one way—by turning the regard inward and observing the operations, the states, the sequences of one's own mind. This is the mode of study that is called introspective; and this, too, is the field of observation to which the term "metaphysical" is most often applied in an opprobrious sense. Although it does not include the whole of metaphysics, it is quite true that this branch of science is a metaphysical study. Before we condemn it, however, it will be fair to get as clear a notion about it as we can. Like every other science, the science of introspective psychology is but a more careful and systematic study of facts that everybody notices in a more or less superficial and perfunctory manner. Every practical man notices the difference between a fit of anger and a chain of reasoning; between the satisfaction of success and the grief of bereavement; between the feeling of warmth and the feeling of fatigue; and every one who takes notice of these differences is dealing with the facts of introspective psychology. He is already a metaphysician; and the difference between him and the professional metaphysician consists only in the additional care and minuteness of observation which are exercised by the latter.

It is evident that every one who pursues this method of investigation can exercise it upon his own consciousness only. He cannot directly feel the emotions that are arising in other men's consciousness, nor can he reflect on the ideas of other people's minds. He knows directly his own consciousness; he knows nothing whatever about other people's consciousness, except what he can gather from their words and gestures and expression. From these observations he infers that other people have consciousnesses like his own, but he can never directly observe them. The study of the grounds upon which we believe that there are other minds outside ours, and the estimation of the validity of that belief, belong to the domain of Philosophy, and are not included in Psychology proper. Psychology takes for granted the existence of other people's consciousness, just as Chemistry takes for granted the existence of different kinds of atoms; and in the one case as in the other a whole science is founded on the supposed existence of things which never have been and never can be directly observed.

So long as we confine our studies to the facts of our own consciousness, we are proceeding on a very narrow basis. It is a method that has immense advantages with respect to its certainty, but it is narrow. If, however, we can include in our study of Mind the study of other men's minds besides our own, it is manifest that our area of observation is enormously enlarged; and if, in addition to the minds of men, we can take the minds of all animate beings, from the most lowly to the most elaborately organised, as a basis for our science, it is obvious that its foundations will be far wider, if not far more secure. Yet the minds of others cannot be known directly. They can only be inferred from the conduct which is their outward expression. Hence the systematic study of conduct becomes an integral part of the science of psychology.

The psychological unit is a *nervous process*, which when transmitted to muscles issues in a *movement*, and is accompanied by a *mental state*. Raise this unit to the highest power, and we find our subject falls into three natural divisions: the study of Nervous Processes, the study of Conduct, and the study of Mind.

PART I

FUNCTIONS OF THE NERVOUS SYSTEM

A

PHYSICAL

CHAPTER I

THE NERVOUS DISCHARGE

We eat and we work. These are the two great functions of the human organism—of all animate beings. All other functions, save the reproductive, are subservient to these two, and these two reciprocally subserve each other. We cannot work without eating; we work in order to eat; and we cannot eat unless we work.[1]

What happens when we eat? Food is taken into the body, and therein undergoes various transformations. It is dissolved, recombined, absorbed, circulated, combined into tissue, oxidised, decomposed, dissolved and ejected. We can sum up all these changes in one word—rearrangement. The atoms and molecules of the substances forming the food are rearranged into solutions, rearranged into blood-plasma, rearranged into tissue, and finally rearranged into combinations which are of no further service to the organism, and which are then expelled. The whole history of the food and the oxygen that are taken into the body consists in successive rearrangements of composition, and changes, that is rearrangements, of place, from the time they enter the body until the moment they leave it. All the functions of mastication, deglutition, digestion, absorption, circulation, assimilation, nutrition, growth, secretion and excretion, are parts of a single process—the rearrangement of matter within the organism.

[1] The term "work" is used, not in its limited sense as equivalent to labour, but in the larger sense of producing movement. When I lift my hand to my mouth, there is work done which can be measured in foot-pounds.

How do we work? By moving our muscles. This is the one and only means by which we can alter the world outside of us. When a muscle contracts, a considerable movement of some part of the body occurs. But even when the muscle has repeatedly contracted, there does not result a large rearrangement of matter within the organism. A little of the muscular structure has been used up; a little new material has been introduced; but at the end of the exertion the arrangement of the muscular structure is but little different from the arrangement that it had at the beginning. Where then has all the motion come from, seeing that motion no more than matter can originate out of nothing? Obviously, the molar motion of the muscles and limbs has been supplied by the transformation of molecular motion. There has not been a large rearrangement of matter, but there has been a large redistribution of force within the organism. The redistribution of force in great quantities and to great distances, without any discernible rearrangement of matter, occurs in every electric-light lead and in every telegraph-wire. The contraction of the muscles is set up by the delivery of a shock of force at a nerve-end—another redistribution of force. This shock has travelled—has been redistributed—from a nerve-centre. The nerve-centre was provoked to emit its force by the arrival of a shock from some other region of the body, and we may continue to trace the communication of force to one part of the body from another, until we ultimately find that the whole process was set going by a force impressed on the organism by some moving thing in the outer world. At every step except the first, and in some cases the last, we find that the passage, or communication, or redistribution of force, is the conspicuous, important and permanent part of the process; while the rearrangement of matter is trifling, or imperceptible, or temporary.

All the bodily organs and all the bodily functions may be divided into two great groups, according as they subserve the rearrangement of matter or the redistribution of force. The latter is, from the physical point of view, the prime function of the nervous system, of which the muscles, bones, etc., may be regarded as mere appendages. While it is, of course, true that the rearrangement of matter is always effected by the redistribution of force, and that the redistribution of force is always accompanied by the rearrangement of matter, and that these conditions are as inseparably linked within the organism as without it; yet, since one portion of this duplex process is in every case primary while the other is merely subsidiary, the distinction between the two is thoroughly valid. That this division of the functions follows an actual line of cleavage which penetrates to the very foundation of the constitution of the organism, is indicated not more by *à priori* considerations than by the multitude and importance of the minor lines of difference that it passes through, coincides with, and connects; and of the complementary factors that it refers to the one side and the other. The functions which subserve the reception and redistribution of matter are those by which the organism exists, while the functions which subserve the reception and redistribution of force are those by which it acts. The first are the so-called vegetative functions; the second are those which are more conspicuously indicative of animal life. The continuance of the first are essential to the continuance of life. Stop the heart, and the man drops dead; arrest the breathing, and he dies rapidly; abolish the function of the kidney—block the intestine—and he has but a few days to live. But the functions of the second group may be abolished *seriatim* without directly or necessarily affecting the duration of life. Blindness or deafness is no bar to longevity. Many a paraplegic lives to advanced life, and if his malady is fatal, it is so not because of the loss of movement, but because of the nutritive changes that accompany the loss. So with hemiplegia, with tabes, with muscular atrophy, with chorea, and with all other disorders of movement, life is not threatened except by the concomitant changes of nutrition or by the invasion of the functions of the first order. Again, the redistribution of matter is continuous; the redistribution of force is intermittent. The blood never ceases to circulate; the interchange of gases in the lungs is never interrupted; the structural changes of growth and development, waste and repair, nutrition, excretion and assimilation, are continually going on. In sleep and in waking, in activity and in repose, day and night, year after year, the structure changes ceaselessly. In life these changes never flag, and when life ends they merge without a break into the final redistribution that takes place after death. But the redistributions of force are not continuous; they occur only at intervals. In the separate pulsations of the heart, in the composition of a muscular contraction, in the to and fro movements of breathing, in the undulations of peristalsis, in the fatigue and repose that follow exertion, in the sleep that alternates with waking life, we see exemplified the irrefragable law that within the organism the redistribution of force is always intermittent—conforms always to that greater law which asserts throughout the universe of Space and Time the rhythm of all motion. Yet, again, while the redistribution of force is the primary function of the highest nervous centres, the redistribution of matter is altogether independent of their direct control. Which of us by taking thought can add a cubit to his stature? or determine the deposition of fat in this place or the absorption of fluid from that? Who can check the proliferation of cells which is forming a cancer in this part, or keep up to the normal standard the defective nutrition which is resulting in atrophy in that? On the other hand not only are the redistributions of force which affect the outward movements of the organism under the control of these centres; not only are the movements of locomotion, handicraft, and speech the direct outcome of their activity, but even the redistributions of force which subserve those of matter—the movements of the digestive, respiratory, and circulatory apparatus—are more or less under their direct control. Differences so pervading and so fundamental fully justify the division of the functions into these two orders.

Redistribution of force means, as we have just seen, the communication of force from one place to another. Matter is communicated from one part of the body to another in the blood-vessels, in which it is continually circulating. Force is communicated from one part of the body to another along the nerves, in which it also is continually circulating. Little waves of force pass along the nerve-fibres, at a rate of about ninety feet per second. The matter of the nerve does not appreciably change its place, the force alone travels, just as a wave passes through a fluid in the way familiar to every student of physics. But redistribution of force means something more than communication of force from place to place, and something more than this is included in the physical functions of the nervous system. Were communication of force the sole function carried on by the nervous system, we could never have a muscular contraction except upon the application of a proportionate stimulus to the surface of the body. The muscles are not always in full action. They contract when a shock is delivered into them by a nerve, and only then. It is obvious that we could not always depend upon having an amount of force, of precisely the requisite amount to cause a muscle to contract, applied to the body at precisely the moment at which it would be convenient for us to have such a contraction. Yet without such a stimulus applied just in the nick of time, no contraction could take place if the nervous system were solely an apparatus for the communication of force. In order that muscles should be made to contract at the right time, there must be a store of force accumulated somewhere in the body and capable of escaping from time to time in such quantity as to set up contractions in the muscles, without immediate and direct provocation from outside the body. To form such a store is the function of the gray matter. The function of the nerves is to form channels of communication along which force may be transmitted from one part of the body to another. The function of the gray matter is to act as a receptacle or reservoir for the storage of force, and to liberate this force at appropriate intervals, in appropriate quantities, and in appropriate directions.

The conception of the storage of force is familiar to every one in the leading case of coal. Every one knows that this homely substance derives all its value from the immense store of force it contains, and the ease with which this force can be liberated when we want it; and it is not difficult to form a moderately clear concept of the means by which the force is held in thrall. The classical illustration is the raising of a stone. When a stone is raised, a certain amount of force is used in raising it. If it is dropped, it strikes the ground with a force equal to that employed in lifting it. If it is again lifted and placed on a shelf, the force employed in lifting it becomes latent or potential. It is not manifested in any way, but it is still in existence, for however long the stone may remain on the shelf, if it is at last pushed over the edge it falls to the ground, and expends in doing so an amount of force equal to that employed in raising it, years, or it may be centuries, before. When the stone was placed on the shelf, the force employed in lifting it was rendered latent or placed in store; when the stone fell, the force was liberated. Now instead of the earth and the stone—one vast mass and one small one—imagine two very small particles, one of carbon and one of oxygen, and for gravitation substitute chemical attraction. So long as the carbon atom and the oxygen atom are kept apart, there is force potential or latent or stored up. When they clash together this force is liberated.

The method in which force is stored up in the gray matter is not, we suppose, quite like the case of the stone on the shelf, nor that of the restrained chemical action. Instead of a stone lifted, imagine a brick set up on end. To do this requires the expenditure of force. Now if the ground is shaken, the brick falls, and liberates in falling a force equal to that expended in raising it. Again, imagine a brick set on end with another brick placed across the top of it. The upper brick can now be knocked off the lower and the force which raised it be liberated, while the lower brick is left standing, with the force that raised it still in store. It is evident that a brick balanced on the top of another one will be displaced by a gentler shake than is required to knock down the single brick. A third brick may be placed on the top of the second, and this may be displaced by a still gentler shake, and its fall will liberate a still smaller part of the force employed in putting the three together. Now suppose more and more bricks are added, until we have quite a complicated structure composed of loose bricks. It is easy to see how readily a top brick could be knocked off —how slight a force would be necessary to upset it, how readily the fall of one would conduce to the fall of more, and how little the fall of a few of the topmost bricks would modify the entire structure, especially if we suppose that they do not fall off the pile, but merely from their ends on to their sides. Now if we imagine these bricks to be connected to the pile by elastic bases, so that when they have been knocked down they will slowly rise again, with perhaps a little help, to their erect position, we shall have a diagram which will represent very roughly what we suppose to be the mechanism of the nervous discharge.

We know that the gray matter of the nervous system has an extremely complex molecular condition. Each single molecule has been calculated to contain nearly one thousand atoms. These atoms are united together in twos and threes, in dozens and scores; several of these clusters are united together to form a larger group, which is again combined with others in several links of cross-relationship. The whole molecule is therefore a very complicated structure, and may contain many atoms and groups of atoms that stand in the position of top bricks.

A structure so complicated is easily disarranged. When a disturbing force impinges against it, the weakest ties between the atoms and groups of atoms will give way, and some of the atoms will fall into new positions, just as the top bricks fall into new positions when the pile of bricks is shaken. Now mark, that in building up the atoms into the complex arrangement found in the molecule, force has been employed—has become latent—has been stored. And when the atoms are shaken into simpler positions, just so much force is liberated as would suffice to build them from this new position back into the old one. This is what is meant when it is said that force is stored up in the gray matter of the nervous system and liberated at intervals. Such a statement means, that the highly complex structure of the molecules of the gray matter is built up by the action of force on the atoms; that the force so employed lies latent in the structure; that the structure so formed is an unstable structure; that the bonds of union between the component sub-molecules are frail and easily broken; that the frailest portions of the structure may be shaken off by a very slight force; and that, when parts are thus shaken down, the force employed in building them up is set free. It is set free in much the same way as the force stored up in a pile of bricks is set free when the bricks fall down, and waves of sound and heat are straightway projected in all directions.

Such an alteration of the structure of a molecule as is above described, since it is an alteration from a more complex to a more simple structure, is of the nature of a decomposition; but since the molecule contains just as many atoms after receiving the shock and undergoing the rearrangement as it did before, there is no decomposition in the chemical sense. When a molecule is decomposed in the chemical sense, the atoms of which it is made up are not merely rearranged within the molecule; they are torn completely asunder, and may be united with foreign atoms to form entirely different compounds. This is not the case in the process that has been described. What happens there is a rearrangement of atoms within the molecule without any disruption of, or loss of atoms by, the molecule. The chemical composition of the gray matter is unimpaired, and a mere lifting of the displaced atoms into their original places will completely restore the *status quo ante*. Thus it can be easily understood how the structure of the gray matter may be continually undergoing decomposition during its functional activity without being permanently or materially impaired. It will be convenient to use the term "decompounding" for this form of rearrangement, reserving the term "decomposition" for the major process which involves destruction. The process of decompounding, with the liberation of force which necessarily accompanies it, together make up the nervous discharge.

Several accompaniments and consequences of this process require notice.

If we suppose, as the extreme complexity of the molecule and what is known of its constitution entitle us to suppose, that all the atoms and groups of atoms that occupy the position of top bricks are not equally unstable, but are bound to the main body of the molecule with different degrees of firmness, then it will be evident that the number of atoms that are shaken out of their places on the impact of a shock will depend on the magnitude of the shock. A stronger shock will displace more atoms than a weaker shock; and since the greater the number of atoms displaced, the more force is liberated, it follows that, other things being equal, the *greater the disturbing force, the more powerful will be the resulting discharge.*

Next we have to notice, that the force set free by the decompounding of a molecule itself acts as a disturbing agent on the molecule. A very feeble impact may be able to displace only the most loosely attached atoms. But these atoms in their fall liberate force, and the force thus liberated may be enough to displace the atoms of the next degree of instability. The fall of those atoms may still further spread the process. Just as the fall of one brick on the top of a pile tends to knock down other bricks; just as the explosion of one barrel of gunpowder in a magazine tends to explode other barrels; so the fall of one atom of a molecule tends to knock other atoms out of their places. Hence *a discharge once begun tends to get stronger.*

Again, the force set free by the decompounding of a molecule is not confined within the molecule, but diffuses around, much as the waves of sound and heat initiated by the fall of a pile of bricks spread around in all directions. But every molecule of gray matter is surrounded by other molecules. Hence the force set free from one molecule must impinge upon others. And when a force impinges upon the molecules of the gray matter, it will, if strong enough, shake their atoms out of place. Hence the discharge of a molecule tends to cause the discharge of other molecules. In other words, *a discharge once begun tends to spread.*

If a number of molecules are aggregated together, and some of them are made to discharge, a certain amount of force is liberated—the discharge attains a certain strength. From the two preceding paragraphs it appears that an increase of strength may accrue to this discharge in two ways. It may spread to more molecules, and be augmented by the force liberated from them, or it may spread deeper into each molecule and be augmented by the fall of additional atoms in each discharging molecule without any increase in the number of molecules discharging. The former is an extension of the discharge—an increase in the area that discharges with a given intensity; the latter is an increase in the intensity of the discharge that issues from a given area. Hence we recognise, that *a discharge may be augmented either by extending in area or by an increase of intensity.*

The force set free by the decompounding of a single molecule is of course inappreciably small; but the molecules are indefinitely numerous, and the accumulation of an indefinitely large number of inappreciably small forces of similar character results in a force of appreciable magnitude.

We have seen how the force stored up in the gray matter is liberated; we have now to ask how it is replaced. By what process, under the operation of what causes, do the displaced atoms return into their less stable position on the molecule? The only answer that we can at present give to these questions is that we do not know. We know that as a matter of fact the atoms are replaced, or that others are substituted for them, for the nerve-centres continue to discharge, and yet do not become decomposed. It is obvious that, if the discharge continued without restoration of the fallen atoms, the process could not go on long; for each successive decompounding would reduce the atoms to simpler and simpler combinations, until at length the molecule would be reduced from a complex cluster of many groups of atoms and clusters of groups to a disorderly heap of single particles. Long before this stage was reached, however, the molecule would split up into smaller molecules, and entirely new combinations would be formed. The gray matter would be chemically decomposed. We know, as a matter of fact, that no discharge is continuous. Every liberation of force is followed by an interval, and a prolonged discharge is made up of numerous separate waves of discharge separated by intervals of inactivity. It is fair to suppose, that during these intervals the fallen atoms are being replaced into a position of greater instability, from which they are again displaced as the discharge is renewed. This replacement of the fallen atoms requires time; it requires more time than is required for their displacement. Hence when discharge follows discharge rapidly and for a length of time, the process of displacement outstrips the process of restoration. The restoration of the fallen atoms being incomplete, the impinging force finds opposed to it a less number of top-bricks—of unstably placed atoms—in the molecule; and the topmost, or most unstably placed atoms being of course those whose restoration is the first to fail, the unstable atoms that are now exposed to the impinging force are less unstable than those which were at first exposed; they require a stronger impact to displace them. As the process continues these atoms also fail to be replaced, and thus, as discharge is repeated, successive layers of atoms in the molecule are laid bare, each stratum being more stable than that which overlay it. At length a stage is reached at which the stability is too great to be overcome by the impact that is applied, and the discharge ceases. In this process we see the explanation of the occurrence of exhaustion and of the restorative potency of rest. After a long interval of rest so high a degree of instability is gained, that the impact of an infinitesimal force is enough to initiate a discharge, which then appears to be spontaneous, and which, once begun, is a cause of its own continuance. After a considerable discharge the degree of stability becomes such that stronger and stronger stimuli have to be applied in order to maintain the discharge. The stimulus of the voice, for instance, is replaced by that of the whip, and the whip is supplemented by the spur. On this hypothesis we see, too, why a short period of very vigorous exertion is more exhausting than much greater exertion spread over a longer proportionate time. In the latter case the intervals are occupied with the process of rebuilding, and their aggregate is sufficiently large to allow of a higher standard of structure being maintained than in the former.

By what agency this rebuilding of the molecule takes place we do not at present completely understand, but we know that there are many similar processes continually going on in the bodies of organisms. The development of the body out of scattered material by the accretion of molecule to molecule and cell to cell is a process of precisely the same character, and one of whose immediate causes we can give no account. The whole function of nutrition, of which the restoration to integrity of discharged nerve-centres is but a single instance, is a process of the same nature. All activity of function is attended by oxidation—by the degradation, that is to say, of some portion of the active tissue into a simpler molecular structure, and all growth, development and nutrition is the integration or redintegration of a simpler into a more complex molecular structure. Since the recompounding of the gray matter after discharge is a portion of the general process of nutrition, it will as a rule vary as general nutrition varies. Hence we find that those people who most readily recoup themselves after exertion—those who require least rest and least sleep — have the reputation of being the longest lived. Hence we find also that such people are the least obnoxious to adverse influences —to extremes of heat and cold, to the influence of alcohol and other drugs—and most readily overcome the effects not only of fatigue, but of various excesses.

The longer the molecules are left undisturbed, the longer does the building-up process continue, and the more and more unstable is the position in which their peripheral atoms become arranged. When a considerable time has elapsed since a molecule was discharged, the position of the atoms becomes so extremely unstable, that the impact of an infinitesimal force will be enough to upset them. It will further follow, that when atoms are in this extremely unstable condition, not only will they be upset by an extremely minute force, but that, once disturbed, the number of atoms that undergo rearrangement will be relatively great. Where a large number of atoms are in extremely unstable positions, a force which is sufficient to dislodge only the most unstable of all will, when it is reinforced by that liberated in the fall of these atoms, produce a widespread collapse; just as a house of cards falls into complete ruin when a single card is displaced. And the more atoms that are displaced, the more force is liberated, the more intense the discharge. Hence the longer a molecule has been left undisturbed, the more prone it is to discharge, and the more force does it liberate when the discharge occurs. In this elementary fact we see the explanation of the recuperation that takes place after rest, of the ease with which exertion of all kinds is undertaken in the morning, of the many phenomena of fatigue, exhaustion, etc. Here also is the explanation of the so-called spontaneous discharge, an occurrence which is never actually spontaneous, but which occurs when the molecules are fully charged, on the provocation of a force so small as to be insignificant. On the other hand, when the molecules have been frequently discharged and have had but few and short intervals for recuperation, the more unstable atoms will all be displaced; and as more and more stable strata are laid bare, greater and greater amounts of force are necessary to displace them; and when an atom is displaced, the connections of surrounding atoms will be so firm, that the displacement is limited to a small area, and the impact of even a considerable force will evoke but a very small discharge.

The function of the nervous system is, as we have seen, not only to store up and expend force, but to carry it from one part of the body to another—to deliver it from the store to whatever place it may happen to be wanted in. It remains to show how this transference is effected. It is scarcely necessary to say, that the liberated force exercises no choice as to the direction it shall take. It spreads from the point of liberation equally in all directions—provided all directions are equally permeable. But all directions never are equally permeable. Not only are the surrounding molecules, in so far as they are of the same nature, differently circumstanced, some being older, some more recently discharged, some better situated for recuperation, than others, but every molecule possesses polarity such that it is more sensitive to shocks arriving in the direction of one of its axes, than to shocks arriving in any other direction, and delivers its discharge in greater intensity along this axis than in any other direction. Hence a discharge will spread more readily where the molecules have their poles parallel than where they are higgledy-piggledy.

The more unstable the molecule, the more completely it is discharged by an impinging force, and the more force it liberates in its discharge. Again, the stronger force is the more efficient disturber, and hence for two reasons the discharge will spread most along the direction in which the molecules are most unstable. Now suppose that the unstable molecules are packed inside a tube whose walls are constructed of molecules so stable that they will not discharge at all, and suppose that they are packed with their polar axes parallel. Manifestly a discharge initiated at any point in the tube will travel with great facility along the length of the tube.

Such is the structure of a nerve-fibre. It is composed of an axis-cylinder of gray matter, enclosed in a tube of substance that will not discharge. We have seen that each molecule that discharges adds something to the force of the total discharge, and hence, if the supposed view is correct, the nerve-current ought to be stronger the longer the tract of fibre that it has traversed; and it is a well-established fact in physiology that "if the irritant remains the same, the longer the portion of nerve irritated, the stronger is its action on the muscle."

Having such a construction as described, when a medullated nerve-fibre transmits a wave of force, this wave is entirely confined to the axis-cylinder in which it runs from end to end. The stably arranged sheath prevents all diffusion of the discharge. But all nerve-fibres do not possess a medullary sheath. Very many fibres are naked throughout their length, and all are destitute of sheath at their ends. From this we may infer that some nerves allow, under some circumstances, a certain lateral diffusion of the currents passing along them, and that this diffusion may occur at the ends of all nerves. We need not suppose, that where there is no sheath there is no restriction of this lateral diffusion, nor that where a nerve-fibre loses its sheath the currents spread from it uniformly in all directions; but we may be certain, from the existence of the sheath, that its absence allows to the currents some lateral diffusion. If not, there is no need for a sheath. When we look at a section of gray matter under the microscope, we see a number of fibres traversing in various directions an intervening substance. The fibres are not divided from the inter-fibrous substance by any sheaths or membranes. No conspicuous difference can be found between their substance and the substance in which they are imbedded. As a rule, the tissue must be considerably altered by immersion in different fluids, or by staining, or both, before any difference at all is discernible; and when the fibres are in this way made conspicuous, very many of them taper off to an extreme tenuity and become at length indistinguishable from the ground-substance. By more elaborate preparations, and by better methods of staining, the fibres may be tracked further and further; they may be traced into prolongations of greater and greater tenuity; but the more perfect our methods, and the more laborious our observations, the more certain it becomes, that the great majority of nerve-fibres taper off into fine points which lie imbedded in the ground-substance. From these observations three inferences may justifiably be drawn. From the different action of reagents upon the fibres and on the matrix, we may infer that the molecular constitution of the fibres is different from that of the matrix. From the precautions and preparations necessary to display this difference, we may infer that it is not very great. And from the increasing difficulty in tracing the fibres as they extend further from their main trunk, we may infer, that the difference between the molecular constitution of the fibres and that of the matrix diminishes as the former approach their free terminations. Viewing them with regard to their molecular stability, it can scarcely be doubted that the molecules of the fibres are more unstable than those of the matrix; but considering the similarity of the two substances, the difference of stability is probably not great, and becomes less as we approach the termination of the fibre. If we accept this view, in favour of which there are several arguments that cannot be reproduced here, we are committed to certain other views regarding the transmission of waves of force, or discharges along these fibres. Suppose a molecule in one of these fibres to discharge. Force is liberated, and, if the molecules of the fibre are supposed symmetrical and similar, spreads in all directions both along and across the fibre. When the discharge has spread through the whole thickness of the fibre, so that all the molecules in a transverse section are discharging, it impinges against the molecules of the surrounding matrix, which, by hypothesis, are not so easily discharged as the molecules of the fibre itself. It is obvious that the next event will depend entirely on the strength of the discharge. If the impact of the force is strong enough to knock down, not only the loose atoms that compose the molecules of the fibre, but also the somewhat more firmly compacted atoms that compose the molecules of the matrix, then the molecules of the latter that abut upon the fibre will be discharged. Discharging, they will liberate force, and will pass on the movement in increased intensity to the molecules lying further from the fibre. Hence, powerful discharges will not only traverse the fibre, but spread into matrix also. If, however, the discharge passing along the fibre has not sufficient force to upset the more stable molecules of the matrix, it will remain limited to the fibre, and will pass along its length without becoming laterally diffused. To suppose that the waves of discharge in the nerve-centres are entirely limited to the fibres, is a mistake, and a very vital mistake. Whether they remain confined to the fibres, or whether they overflow and permeate the imbedding substance, depends, other things being equal, on the strength of the discharge; and the possibility of their escape from the limits of the fibre into and through the surrounding substance is one of the most important properties of nervous tissue, and the foundation of one of the most valuable of all faculties —the faculty of progress.

Not only may a current, if sufficiently powerful, escape from the fibre and spread through the ground-substance, but there are circumstances in which a current in a fibre, however feeble, *must* become diffused into the surrounding matrix. Suppose the case of a fibre which tapers off and ends, after a longer or shorter course, as an attenuated point. What becomes of a current of force when it reaches this termination? Again, we must consider the process as an affair of decompounding molecules. If we take a number of cross-sections of the tapering nerve, the area of each section becomes less and less as we approach the point. The structure of the fibre being supposed uniform, it follows that the number of molecules exposed in each cross-section becomes less and less in each successive section. In other words, as the wave travels along the fibre, the discharge of a number of molecules is passed on to a less number. The force impinging on the less number is not less than the force impinging on the greater number. On the contrary, it is greater, for it is reinforced by the discharge of the latter. But the same amount of force when applied to a less number of molecules will produce a greater effect upon each than when applied to a greater number,—it will discharge the less number more completely. In other words, as the discharge approaches the termination of the fibre, it increases in intensity. When the discharge reaches the extreme point of the attenuated fibre it will have a considerably greater intensity than it had where the fibre was considerably thicker; that is to say, its impact against the molecules that lie round the point of the nerve will be more powerful than its impact against the molecules that bound the fibre laterally; and hence a discharge which is not powerful enough to escape laterally from the fibre, may yet have sufficient impetus to escape at its termination. When we remember that the molecules of the matrix, although more stable than those of the fibre, are not much more stable, it will be evident that when currents of various intensity are very frequently passing along the fibres, there must occasionally occur some that are not powerful enough to discharge those molecules of the matrix that surround the course of the fibre, but yet gather intensity enough to discharge those that surround its termination.

So far, we have discussed the nervous discharge without once mentioning the nerve-cells, an omission that may well arouse astonishment, but one that has been made designedly. It is customary to regard the nerve-cells as unique bodies possessing wonderful and even miraculous powers. They are able, it is said, not only to transfer force from one fibre to another, but to transmute a wave of force into a conscious sensation, and an idea into a movement; they are able to suppress movements; not only force but memories are stored away in them; they are the active portion of the nervous system, the remainder being either mere packing or merely subsidiary and supplementary material. Most of these views are certainly erroneous, and all require modification. The nerve-cells cannot transmute a movement into a feeling or an idea into a movement. They cannot contain memories. They are not the only active portions of the gray matter. That they are active constituents of the gray matter admits of no doubt; but they are far from being the only or even the most important of such constituents.

The nerve-cells are continuous with the fibres. It is common to speak of a fibre as entering a cell; but the connection between them will be more correctly conceived if the cell is regarded as a bulging of the fibre, and the fibre as a prolongation of the cell. There are, it is true, cells which appear to be isolated, and which have no discernible connection with any fibre; and it is extremely significant that these cells have no cell-wall, and are less distinguishable from the matrix in which they are imbedded than any other form of cell; but the great majority of cells are continuous, with the substance of one or more fibres. Between the molecular structure of the cells and the molecular structure of the fibre there appears to be some difference, but assuredly the difference is not great. There is no line of division between them. The one merges by insensible degrees into the other. Their optical appearances and their response to reagents are almost identical, and whatever differences can be found to exist between them are largely explicable by the greater bulk and different form of the cell —by the different mode of aggregation of the molecules. Supposing, for the sake of argument, that the cells are composed of molecules precisely similar to those of the fibres, still the function of the cells, or the manner in which their molecules as a whole behave under the impact of a force, will be different from that of the fibre-molecules. Let us see what this difference will be.

The main difference in aggregation between the cell and the fibre, is that within any given distance, greater than the diameter of the fibre and less than that of the cell, there is a much greater number of molecules in the cell than in the fibre. Supposing a cell to have a diameter only ten times as great as that of a fibre, which is a moderate average, and to be of similar uniform molecular constitution, then, if discharges of equal intensity are started from the middle point in the long axis of each and spread to the circumference, the discharge in the cell will liberate 1000 times as much force as that in the fibre, and will occupy only ten times as much time, so that in each unit of time the cell will liberate on the average 100 times as much force as the fibre. In other words, the discharge in the cell is of a more explosive character than that in the fibre, supposing both to be similarly constituted and to be similarly disturbed by equal forces. It is possible that the molecules of the cell are more unstably constituted than those of the fibre, but of this we have no evidence. But since most cells are a meeting-point for several fibres, it is obvious that while the impinging force which sets up a discharge at any point of a fibre can arrive in one of only two directions, that which discharges a cell may arrive from several directions, in some cells probably from any direction.

Since a large cell contains more molecules than a small one, it will, if similarly constituted, liberate more force in its discharge; and since the more explosive character of the discharge in the cell depends on the longer radius that can be drawn from the starting-point of the discharge to the periphery of the cell, it is obvious that a large cell will liberate force in a more explosive manner than a small one. Hence where an effect depends on both the amount and the suddenness of the discharge, the larger cell will have the advantage in both ways. It is significant that large nerve-cells are specially characteristic of motor regions.

Reference has been made to the fact, that some cells have no fibres in direct connection with them. Such cells —I speak only of those that are admitted to be nerve-cells —must have the same fundamental function as other nerve-cells—must accumulate force, and discharge it upon provocation. But since they have no fibres, the only possible way in which the jar necessary to upset the equilibrium of their molecules can reach them is through the matrix in which they are imbedded; and the only possible way in which the force liberated by the discharge of such cells can escape is through the matrix. Now we can see the significance of the fact already alluded to, that apolar cells are but indefinitely demarkated from the matrix in which they lie. Were it otherwise, they could exercise no function, for any boundary between the discharging molecules of the matrix and the charged molecules of the cell would prevent the former from acting on the latter. The same barrier would imprison the discharge and prevent it spreading. As it is, such cells may be looked on as but slightly differentiated portions of the matrix. They are separated from it by no defined boundary, and can freely receive and impart impulses from and to it. The existence of such cells is an additional argument for the active function which is here claimed for the matrix of the gray matter.

Having now considered separately in the fibre and in the cell the molecular movements which constitute their function from its physical aspect, let us see in what way these movements will be modified in their passage from the fibre to the cell, and from the cell to the fibre. For the present purpose, those cells which are directly continuous with fibres may be regarded as bulgings in the course of fibres—as protuberances at a place of division. Now, suppose a wave of discharge to proceed along a nerve-fibre, and to arrive at one of these bulgings, what will happen? From the point at which the nerve joins the cell a discharge will spread through the whole cell-substance. The cell will discharge in an explosive manner, and will liberate a relatively large amount of force in a short time. This force, liberated by the molecules within the cell, seeks to escape. A head of pressure is established which tends to a restoration of equilibrium by flowing off in directions in which pressure is less. The force is pent up in the cell much as condensed gas is pent up in a soda-water bottle. It presses in all directions against its envelope. But the boundary of the cell is composed of material which is, metaphorically speaking, too rigid to yield to the pressure. The bounding molecules are too stable to be upset by any force that can be liberated within the cell. The force has to escape whereever there are openings in the boundary—in other words, wherever the cell-substance is prolonged into fibres; and these openings are few and small in comparison with the whole area of the cell. As in other cases where a considerable pressure escapes through few small openings, the rush through each opening will be of considerable intensity—of much greater intensity than would be the case if the force escaped freely over the surface of the discharging cell. We see, therefore, that for many reasons the discharge of a cell along the fibres emerging from it will be far more powerful and far more intense than the discharge whose entrance set up the discharge of the cell. In other words, a discharge in passing through a cell undergoes three changes. 1. Except in bipolar cells, which are few, it is communicated from a single fibre to several fibres. 2. It is increased in force. 3. It is increased in intensity. This increase in the force and intensity of the discharge is very great and sudden, and in comparison with it the increase gained by a discharge in passing along a fibre is insignificant in amount, and, what is perhaps of more importance, is gradual in its accession. For these reasons the term "discharge" is often limited to the process as it occurs in the cell; the process as it occurs in the fibre, although identical in nature, being neglected.

So far we have dealt with the physical functions of the gray matter as occurring in a structure of constant composition. We have considered the force set free by the discharge of the molecules as travelling from place to place, becoming diffused, impinging against other molecules, and effecting their discharge. We have followed the course of the discharge from the fibre to the cell, and from the cell to the fibre, and we have not forgotten that it may permeate the matrix also. But every disturbance that has yet been noticed is purely and necessarily a temporary one. If the change produced in a molecule by the rearrangement of atoms which constitutes its discharge were a permanent change, it is obvious that the molecule would be of no further use. Thenceforth it would be only an obstruction and an encumbrance. Only on condition that the fallen atoms are replaced, and the molecule restored to its previous condition, is a further exercise of function possible. All that we have at present considered is an oscillation of structure from a condition of less stability to a condition of greater stability and back again; this oscillation of structure being accompanied by a concomitant variation of function, the molecules now liberating, now accumulating, force. We have now to notice that, besides this temporary effect, there is produced by each discharge a permanent effect, which is of enormous importance, and which is the basis of the psychological function of the gray matter, as the changes of which we have hitherto spoken are the basis of its physiological function.

Every wave of force that passes through the gray matter discharges all the molecules, against which it breaks, that are sufficiently unstable to be affected by it. Whether a molecule is discharged by a force depends upon three conditions. First, on the constitution of the molecule as stable or unstable; second, on the degree to which, if unstable, it has recovered from a previous discharge; and third, on the direction with respect to its polar axis from which the force arrives. Some molecules, even of extreme complexity, such as those composing the medullary sheath of nerves, are of such stable constitution as to be incapable of discharge, and probably all molecules in the gray matter are not equally susceptible to this change. A molecule which has recently been deeply discharged, and has not had time for recuperation, will not, it is manifest, suffer discharge except on the impact of a very powerful force. But supposing all the molecules of a tract of gray matter to have a similar constitution, and to be equally charged, then the facility with which a discharge passes through it will depend on the condition of the third factor—on the degree to which the direction of the wave approximates to the direction of the poles of the molecules. Suppose that the poles of all the molecules are parallel to one another, and suppose that the impinging force travels in the polar direction, then it is obvious that the facility for the passage of the discharge is at a maximum. Such a molecular structure is the most permeable possible. But now suppose that the discharge passes through a structure in which the majority of the molecules have their poles in the direction of the course of the discharge, but some are placed obliquely at various degrees of inclination to this direction. Such a structure is manifestly less permeable to the discharge than the previous structure. Hence, when discharges of equal strength enter a given thickness of each structure, a less amount of discharge will emerge from the second tract than from the first. A residue of force equal to the difference between the two discharges on their exit has been retained in the second tract. What has become of this force? In what way has it been disposed of? *It has been used up in shifting the molecules so as to bring their poles nearer to parallelism.* Whenever a discharge passes through a tract of gray matter which has not reached its maximum of permeability, a part only of the discharge issues from the tract, and the remainder is spent in rendering the tract more permeable. The less permeable the tract, the greater the proportion of the discharge used up in increasing its permeability. The more permeable the tract becomes, the less the proportion of the discharge devoted to this purpose, and the greater the proportion that emerges. When the permeability reaches its maximum, the discharge that emerges is actually greater than that which enters, owing to the accession that it receives from the decompounding of the molecules. How the passage of a wave of force through an aggregate of molecules of different degrees of stability changes the less unstable molecules into more unstable ones, is perhaps not yet precisely ascertained. Those who desire to pursue the subject will find it discussed at length in Mr. Herbert Spencer's *Principles of Biology*, §§ 3 to 23, and 304; and in his *Principles of Psychology*, §§ 223 to 230. It will be enough here to quote two illustrations from those great works, which serve to give an accurate notion, not indeed of the kind of change that takes place in this particular instance, but of the manner in which a force in passing from particle to particle may be expended in two ways, part being absorbed in altering the disposition of the particles, and the rest being passed on to the extremity of the series of particles. "Take the rude analogy furnished by a row of bricks on end, which overthrow one another in succession. If such bricks on end have been adjusted so that their faces are all at right angles to the line of the series, the change will be propagated along them with the least hindrance; or, under certain conditions, with the greatest multiplication of the original impulse. For when so placed, the impact each brick gives to the next, being exactly in the line of the series, will be wholly effective; but when they are otherwise placed it will not. If the bricks stand with their faces variously askew, each in falling will have a motion more or less diverging from the line of the series; and hence only a part of its momentum will impel the next in the required direction. . . . Suppose that the row of bricks, which were at first very much out of parallelism, have fallen, and that part of the motion given by each to the next has gone towards bringing their faces nearer to parallelism; and suppose that, without further changing the positions of their bases, the bricks are severally restored to their vertical attitudes; then it will happen that if the serial overthrow of them is repeated, the actions, though the same as before in their kinds, will not be the same as before in their degrees. Each brick, falling as it now does more in the line of the series, will deliver more of its momentum to the next; and less momentum will be taken up in moving the next towards parallelism with its neighbours."

A further consequence of this increasing permeability of the tissue to the discharge will be the increasing limitation of the discharge to narrower and narrower channels. "Along a line of discharge, there is a genesis of the matter most capable of communicating the discharge. Every time an incipient nerve is traversed by another wave of molecular motion, there is apt to be a further formation of the molecules which are isomerically transformed by the wave, and pass it on in being transformed. This process acts with continually increasing power for two reasons. One is that progressing limitation of the wave to a well-marked line enables it to produce more decided effects along that line. An illustration will here help us. When a body of water flows over a surface offering no distinct course, it thins out into widespread shallows near its margin, where it is almost motionless; and it has but little motion even along its central deepest parts. But if the inundation is long continued, the abrading action of the current along these central deepest parts where it moves fastest tends to deepen its channel there more than elsewhere. A secondary result is a retreat of the water from the shallows—the current becomes more concentrated. In proportion as it becomes more concentrated, the force of its central part becomes greater still, and the deepening more rapid, which entails a further drawing-in of the margins and a further addition to the excavating force, so that the growing definiteness of the current brings a growing power of making its channel quite definite. Now, though in the case before us we have not a motion of matter over matter, but a transfer of molecular motion from molecules to molecules, the parallel holds. Any greater effect produced by the transfer along one part of its originally broad course, similarly tends to concentrate the transfer along this part, and thus to intensify the action which makes this part a precisely marked channel. A further facilitation results from an absolute increase in the amount of the nervous discharge. The more permeable the line of molecules becomes, the greater becomes the initial quantity of molecular motion it draughts off. As with water, the formation of a definite channel not only makes the transfer easier and adds to the excavating power of the current, supposing its volume be constant, but also (if the reservoir can supply more) augments the volume carried away, which again adds to the excavating power, so the formation of a better line of nervous communication is followed by an increase of the wave that sets out to traverse it, and a consequent increase in the channel-making action. Once more, every addition to the molecular motion transmitted adds to the effectiveness of each discharge in overcoming an obstacle. Suppose the greater part of its channel has become tolerably permeable, but that at some place in it the colloidal matter is less transformed than elsewhere into the fit type. Then the more the rest of its channel increases in permeability, the more powerful must be the wave of molecular motion brought to bear on the untransformed part, and the greater must be the tendency to transform it. Hence the channel will progress towards a state of uniform permeability."

From what has gone before, the reader will have perceived that the freely permeable channels of communication, or the lines of aggregation, of the most unstable molecules are the nerve-fibres. This is common knowledge. What is not so generally recognised is that other channels of communication exist. Apart from the foregoing reasoning, and from all question of the mode of origin of nerve-fibres, there is ample evidence of the existence of such other channels. It is a fact that a vast number—an overwhelming majority—of the nerve-fibres in the gray matter end at one extremity as fine points—have no discernible channel into which the waves of force that traverse them can be delivered. Each advance in our means of research enables us to trace these nerves a little further; but still their destination eludes us, the newest researches show us no more definite ending than a tapering point. If the matrix of the gray matter has no carrying function, each of these fibres is functionless. They are all histological abortions—tentative efforts, which have failed, to connect distant cells. An hypothesis which involves the supposition that the immense majority of nerve-fibres are so much waste material, is monstrous. According to the views that are here advocated, such fibres are merely portions of channels. They are those portions in which the process of mobilisation is complete; and they are supplemented by prolongations in which the process is incomplete—in which the molecules that have acquired the maximum of instability, and at the same time have acquired the power of acting differently on reagents and on light, do not constitute a sufficient proportion of the molecules forming the whole channel to give it, as a whole, optical and other qualities so distinct from the surrounding matrix as to enable us to recognise it as different. This is not mere hypothesis; for where we have a reagent which affects more powerfully than previous reagents these altered molecules, it enables us to trace the nerve-fibres further than a less powerful reagent.

In other words, it brings into view prolongations of the fibres that were before invisible.

It is not, however, necessary to suppose that every nerve-fibre is prolonged by a definite, if invisible, channel to an ending in a nerve-cell. If the doctrines here advocated are correct, there must be many, very many fibres that have no such definite termination. It is one of the most vital principles of that neurology which forms the basis of psychology, that nerve-fibres and nerve-cells are not the only channels of communication in the gray matter. If the visible channels terminate in channels which are not sufficiently differentiated from the matrix to be visible, the inference is obvious that the discharge, which in passing along the visible channel is restricted to that channel, may, when it reaches the invisible channel, begin to spread into the matrix which is so little different. And if the fibres are gradually formed out of the matrix by the passage through it of discharges, then of course the matrix must be permeable to the discharge. This doctrine supplies functions at once to those apparently aimless fibres that, ending in free terminations, constitute so large a bulk of the gray matter, to the interfibrillar matrix which forms a still larger proportion of it, and to the apolar cells, which if visible fibres are the only channels of communication, are anomalous superfluities.

The conception of the physical condition of the gray matter that we have now reached is this. It is composed of complex molecules whose atomic constitution is such that they readily undergo internal changes without being disintegrated. These changes are of two main orders. One, which occurs on the impact of a force, consists in the fall of the atoms into more stable positions, and is accompanied by a liberation of force from the molecule. The other is the reverse change, and consists in the restoration of the fallen atoms to their previous positions, and is accompanied by a storage of force in the molecule. An illustration of these changes may be found in the waves of movement that pass over a cornfield under the pressure of the wind. Each stalk of wheat bends down under the impact of the wind into an inclined position, and in doing so strikes against other stalks and liberates the force which we recognise by rustling sound. No sooner is the bending complete, than the elasticity of the stalk asserts itself and the ear rises into the erect position, ready for the next gust of wind to bend it down again. The two movements occur in alternation, one under the influence of an external force, the other under the operation of intrinsic forces when the outside force has ceased to act. The greater the impinging force, the greater the depression of the ear. The more stalks that are affected, the wider the wave; the more each stalk is bent, the deeper the wave. Finally, the wave of movement passes from one end of the field to the other without any redistribution of the stalks of corn.

All the molecules of the gray matter have not the same susceptibility to these changes, or, what is more probable, the molecules are not equally susceptible in all positions with regard to the disturbing force. If we imagine the stalks of corn to be oval in section, it will be evident that they will bend more readily to a wind in the direction of the short axis of the oval than to one in the long axis. If there be much difference between the axes, the stalks will not bend at all in the direction of the long axis; and if each gust of wind which strikes them on either side of the long axis is able to twist them slightly, so as to turn them more broadside on to a similarly directed gust, these properties will have a still more extended analogy to those of the molecules of the gray matter.

Such being the structure of the gray matter, we have now to get a clear conception of its function in physical terms. To do so, we must imagine the structure thus described as permeated continually and throughout by innumerable waves of discharge. We must recognise that there is a circulation of force in the body, just as there is a circulation of matter. The latter takes place mainly in the blood-vessels, the former mainly in the nerves; and the two are in many respects comparable. Along every nerve-fibre gushes of force continually succeed one another, as waves of blood pass through the arteries. Every nerve-cell is, as it were, a heart, which receives the current flowing into it and discharges it with increased impetus. Every tract of matrix is comparable with the intercapillary tissue. As the blood plasma soaks through such tissue in no constant direction, without definite boundary and with inconsiderable impetus, so the nervous discharge diffuses itself through the matrix of the gray matter in no definite channel, and with an impetus inferior to that which obtains in the nerves. As through the intercapillary tissue new capillaries are formed by protrusions from the old, so in the matrix of the gray matter new fibres are formed by protrusions from the old. Not only in the gray matter do these currents of force circulate; they are carried by the nerves to the uttermost parts of the body. There is scarcely a recess or nook of the organism to which they do not penetrate. While by far the greatest quantity is draughted into the muscles, large supplies go to all the tissues, where their access regulates those molecular disintegrations, rearrangements, and integrations that constitute nutrition and waste, secretion and excretion. The force thus expended is continually being renewed from the store that accumulates in the nerve-cells in the intervals of their activity. But however highly charged a nerve-cell may be, it never discharges spontaneously. However unstable its molecules, some force, even if infinitesimal, is needed to set the process going. Spontaneous movement, in the sense of movement originating without previous movement, is unknown—is, as far as we know the constitution of the universe, impossible. It implies a creation. We have to account, then, for the first shock that sets all the movement going. If we trace a discharge back from fibre to cell and from cell to fibre, we must always come at last to currents that arrive from outside the gray matter along the nerves that are called sensory or afferent. There is no other possible source for the first shake that sets all the movement going. And when we trace this afferent fibre to its extremity, we always find that it rises somewhere on the physiological surface of the organism—somewhere where forces from the outside world can act upon it, and originate the currents which, when they arrive at the gray matter, act as exploders. Further, we find that from all parts of the surface of the body nerve-fibres start and travel inwards to the great central masses of gray matter. And, furthermore, we find that several parts of the surface are especially modified, so as to collect and transmit to these nerves extremely slight disturbances arriving at the surface; such are the organs of special sense. To complete our conception of the physical function of the nervous system, we must therefore picture to ourselves waves of force starting from all parts of the surface of the organism, and converging towards the great central masses of gray matter. Here they are sparse and feeble, there they are stronger and more numerous; and from special areas, such as the retina and the internal ear, they run in powerful currents. Arriving at the gray matter, these currents join in and reinforce the general molecular turmoil which goes on there; and which eventuates in far more powerful currents that are continually distributed to the rest of the organism. The greater part of these outgoing currents are supplied to the muscles, and are supplied, as has been said, continually. So long as the muscles are at rest, the currents reach them in sufficient amount to maintain only that incipient contraction which we call their tone; but that even this is continually varying in amount is shown by the success of the muscle-readers, who can discriminate varying shades of muscular tension which are unknown to the individual in whom they occur. From time to time stronger draughts of force issuing from the gray matter reach the muscles in sufficient quantity to initiate the contractions by which our movements are made. Thus, partly as mechanical movement, partly as heat and other forms of molecular motion, the force accumulated in the nerve-cells passes out of the organism, and the redistribution, so far as the organism is concerned, is complete.

CHAPTER II

THE NERVOUS RESISTANCE

THE foregoing account of the physical functions of the nervous system is, of course, inferential; in some particulars it is very indirectly inferential. We cannot directly observe the passage of currents of force in the nerve-fibres nor the discharges of force from the cells. We decide that the fibres are carriers of force from many indications, chief among which is the fact that no other function can reasonably be ascribed to them, and the further fact that when detached from the cells they can readily be made to act as force-channels. By detaching the nerve-fibres from the cells, and subjecting the cut ends to artificial influences, we cannot only transmit currents of force along the nerves, but we can so arrange that the currents that we send shall produce effects which are the counterpart of those that occur when the nerves are normally *in situ* and attached to the gray matter. Hence we may very fairly infer that the normal influence derived from the cells is similar to that by which we can artificially produce the same effect. And this is not all; for by a further modification of the agent that we apply to the severed nerve, we can produce effects similar to those which occur in the disordered action of the gray matter. The value of such experiments it is difficult to exaggerate.

Taking electricity as the most convenient and manageable agent for acting on the nerve-substance, we find first the familiar but very striking fact, that when a current of electricity is passing through a nerve which has a muscle at the further end, no effect whatever is produced on the muscle. Only at the moment at which the current undergoes a *change* does any contraction of the muscle take place. At the first application of the current to the nerve there is a contraction of the muscle. On the cessation of the current there is a contraction. Any sudden alteration either in the direction of increase or decrease is attended by a contraction. But so long as the current is constant contraction is absent. From this it appears that what produces the passage of the peculiar and specific nervous impulse along a nerve is a *change* occurring at its termination. The effect of the passage of one of these single impulses along a nerve and into a muscle is what is termed a *simple contraction* of the muscle. It is a sudden shortening to a certain point immediately followed by relaxation and a return to the *status quo ante*. Now, save in the case of the heart, this is not the normal action of a muscle. The heart, it is true, acts in this way, but each other muscle shortens with a much more gradual action than occurs under the impulse of a single nerve shock; and when shortened, it does not immediately become completely relaxed, but lengthens by a more or less gradual process, or even remains contracted for some length of time. By reducing the strength of the stimulus applied to the nerve end, we do not reduce appreciably the suddenness of the contraction; and by increasing the strength or continuing the application of the stimulus, we cannot prolong appreciably the period of the contraction. What we can do, however, is this. Instead of prolonging the application of the stimulus, we can apply it repeatedly at short intervals, and then each application will produce a simple contraction of the muscle. If the stimuli are made to follow one another with a certain rapidity, we can produce a succession of simple contractions divided by short intervals of time. If the rapidity of succession of the stimuli be now increased, the intervals between the simple contractions become shorter and shorter until they vanish, and each simple contraction begins at the moment that the relaxation from its predecessor ends. Now, if the rapidity of the stimuli be still further increased, what will be the effect? The effect will be that each simple contraction will begin at a moment before the relaxation from its predecessor is complete. It will be a new contraction added to a small amount of contraction already existing. The contraction will start as it were from a more advantageous position, and it will be more complete,—that is to say, the shortening of the muscle in this contraction will be equal to the shortening in the previous contraction plus the amount of shortening existing in the muscle when the present contraction began. As a matter of fact, the excess of shortening of the second contraction over the first will not be quite as great as here stated. It will be less than the amount of shortening already existing when the contraction began.

Now, suppose a third contraction to follow at a similar interval to the last. Here it is obvious that the muscle will again be caught before its relaxation is complete; and it will be caught at an earlier stage—at a stage when the relaxation was less complete than before, and the amount of shortening in this contraction will be still greater. But it is found in fact that the excess of shortening of the third over the second contraction is less than that of the second over the first.

If the series of impulses is continued at similar intervals similar results follow, the muscle becoming shorter at each contraction, and relaxing less in each interval; but the excess of shortening of each contraction over the last diminishing until after open contraction it disappears altogether, and each impulse produces a contraction which begins during the relaxation of its predecessor, and shortens the muscle to the same extent as its immediate predecessors, but to a considerably greater extent than the muscle was shortened by the first simple contraction of the series.

It will be seen that by this method we have produced a contraction of the muscle which is of greater extent, and, taken as a whole, is of more gradual onset, and maintained with slighter remissions than those of a succession of discrete simple contractions.

If the rapidity of succession of the impulses be still further increased, the time between the culmination of one contraction and the commencement of the next is further diminished, the amount of relaxation permitted between two successive culminations is diminished, and the extreme of shortening is more steadily maintained. It is possible to increase the rapidity of the impulses to such an extent that the relaxations have not time to become perceptible. No sooner has one simple contraction reached its culmination than another catches the muscle ere the relaxation has well begun, and so sustains the shortening at a point that is almost fixed. Then, when the rapidity of the impulses is such that the remittent character of the contraction is no longer perceptible, we have the ordinary phenomenon of a normal contraction—a contraction of gradual rise and continuous maintenance.

Such being the manner in which a normal contraction can be artificially produced, it can hardly be doubted that such is the manner in which normal contractions are produced in the living body. They are produced by the impact on the proximal ends of the nerves of a succession of discrete impulses at very short intervals of time. The question at once presents itself—What can be the mechanism of such a succession of shocks? How is it produced?

The accumulation of force in the nerve-cells under the influence of the general laws of nutrition would appear to be not an intermittent but a continuous process. There is no evidence to show that such accumulation is intermittent, and even if it were, it would not account for an intermittent discharge, for the recuperation of nerve-cells goes on always, but their discharge occurs only occasionally. Under what conditions, then, can a continuous tension in the nerve-cell find vent in intermittent discharge? Let us look elsewhere and find another example of the same phenomena. A closely parallel illustration is afforded by physics. When the disc of an electrical machine is turned, electric tension on the prime conductor increases continuously until it exceeds the resistance of the air, and then a sudden discharge takes place. As the working of the machine is continued, the tension increases again until the same point is reached, and then follows another discharge. So long as the machine continues to work, so long do the separate, discrete, intermittent discharges follow one another at equal intervals. Here, then, we have a series of intermittent discharges at equal intervals produced by a continuously accumulating force pressing against a constant resistance. Is it not possible that the same effect may be produced in the nervous system by similar conditions? May we not justifiably suppose that the tension which has been shown to be present in the discharging cell, and which has been likened to the pressure against the sides of a soda-water bottle, escapes not by the entire removal of the barrier which imprisons it, but by accumulating until it reaches such a tension as momentarily overcomes the resistance, which then closes in again and has to be overcome again and again by a repetition of the process? That such an arrangement would satisfy the conditions and produce the effect that we find appears obvious; but if the arrangement be indeed similar to that of the discharging electric machine, then similar variations in the conditions should produce similar variations in the results in the two cases. Let us see if this be so.

The electric machine being turned at a certain constant speed, the discharges follow one another at equal intervals of time. But as the operator gets tired and turns the machine more slowly, the electricity is less rapidly generated, and it will take longer before the tension on the prime conductor equals the resistance of the air. As the speed of generation and therefore of accumulation diminishes, so does the interval between two successive discharges increase. What is the analogous condition in the gray matter? It is the condition of fatigue—of approaching exhaustion. When the gray matter has been discharging for a long time, it has been shown that it will require a stronger stimulus to produce the same amount of discharge. In other words, the same stimulus will produce a weaker and slower discharge. The slower discharge produces a tension that accumulates less rapidly, and consequently the intervals between successive impulses or escapes of discharge will be longer. But when the interval increases between successive impulses sent to a muscle, the elementary simple contractions, which make up the ordinary "tetanic" contraction, are no longer fixed together. Each simple contraction has time to relax a little before its successor comes and brings the muscle again to its previous extent of shortening. Hence if the hypothesis above formulated is correct, the first symptom of fatigue from long-continued contraction of a muscle should be the breaking down of its continuous action into an action slightly remittent. And what do we find? What follows when a man carries in his hand a heavy weight until he is thoroughly fatigued? He gets home, he sets down his bag, and sits himself down to write. The first thing he says is, "Gracious, how my hand shakes!" His hand is affected with *tremor;* and tremor is the breaking down of the continuous action of the muscles into an action that is slightly remittent. Tremor is that modification of the normal muscular action which occurs when the successive simple contractions follow one another too slowly, and when the beginnings of the relaxations become apparent. If the hypothesis here advanced is correct, then the greater the exhaustion of the gray matter, the longer will it take to accumulate the tension necessary to overcome the constant resistance,—that is, the longer will be the intervals between the successive discharges, and the more complete the muscular relaxation in the interval. And it is a fact that the tremor of slight fatigue is a very fine and rapid tremor; while, as fatigue increases, the tremor becomes coarser,—that is to say, the oscillations become slower, and their extent or excursion becomes greater. If this hypothesis is correct we should expect to meet with tremor, not only in fatigue, but in all conditions in which the rate of accumulation of tension in the gray matter is diminished. We judge of the rate of accumulation of tension by the general activity of the individual. Since the gray matter is the distributer of force to the whole of the organism, the activity of the gray matter may be inferred from the amount of vigour manifested by the organism. Hence we expect to find tremor when the vigour of the organism is low. And we do so find it. In any exhausting illness the limbs tremble on exertion. In paralysis agitans when the whole nervous system is doing its work badly—when there is, as the name implies, and as the aspect and condition of the sufferer shows, great loss of nervous vigour—there is tremor. In general paralysis there is tremor. In drunkenness there is tremor, and the tremor is worst at the time that every symptom points to the lowest ebb of nervous tension—in the early part of the day.

We have supposed the resistance to remain constant, while the rate of accumulation of tension varies. But suppose the resistance varies in magnitude, what will be the result? Returning to our illustration of the electrical machine, when the resistance is increased by increasing the distance that the spark has to travel, the tension must reach a higher point before it can overcome this increased resistance; and if the handle is turned at the same rate, to reach a higher point the tension must have a longer time to accumulate. So that one effect of increasing the resistance will be to increase the intervals at which the shocks are given out. Since the tension must overcome the resistance before the discharge can take place, and since the resistance is increased, the tension at the moment of discharge must be increased. Hence we have this result, that as the resistance is increased the discharges become stronger but wider apart. In the case of the electrical machine we know that this is so. As we increase the resistance of the air by increasing the distance that the spark has to travel, we increase the magnitude of the sparks, but render their succession slower. In the case of the nervous system, we cannot alter the resistance at will, and indeed our only means of judging of increased resistance would be by variation in the strength and rapidity of the simple contractions, so that we are in danger of arguing in a circle; but this we can do: we can see if there is any condition in which the magnitude of the simple contractions bears, while varying, a direct proportion to the varying magnitude of the intervals between them; and if such a concomitant variation is found we may justly say, first, that it entirely harmonises with the hypothesis with which we started; and, second, that it is difficult to conceive any other disposition of forces that would so completely and satisfactorily and simply account for all the phenomena. The concomitant variation of magnitude and rapidity of simple contractions is to be found in the course of almost every epileptic fit. In an epileptic fit, beginning in the face, the opening spasm is "tonic" in character,—that is to say, the movement of the part affected is even and regular like an ordinary natural movement. The eyes turn to one side, or the corner of the mouth is raised with a movement so gentle and natural that, but for what follows, we should not know that it was part of an epileptic fit. The next thing is that the eyelids or the cheek, as the case may be, begin to quiver with a fine vibration, the simple contractions are beginning to get separate, and at the same time the spasm is manifestly stronger. As the fit progresses the fine vibration becomes coarser and coarser, and at the same time the spasm becomes stronger and stronger, producing greater and greater contortions. By the time the limbs have become involved, the spasm has become markedly clonic in character and of great violence. Now, as the fit passes off, the several shocks come more and more slowly, but assume a greater and greater intensity, until at length a condition of complete and universal relaxation and flabbiness separates from one another the shocks, which, coming now at the rate of only one or two in a second, are of tremendous violence, and seem as if they would break the very bones. At last one terrific spasm, coming and going with the electric suddenness that characterises the simple contraction, ends the fit.

So far as the concomitant variation of strength and rapidity of shocks can support the hypothesis of nervous action here advanced, the phenomena of such a fit as that described, which is a very common one, corroborate it completely. If explained by the hypothesis, the phenomena suppose of course that the resistance to the discharge gradually increases from the beginning to the end of the fit; and without speculating as to how this increase takes place, I should have no doubt that it actually occurs. And if it do occur, then we draw this important conclusion, that in the balance of tension and resistance, which we suppose to exist in the gray matter, not only does the rate of accumulation of tension vary, but the amount of resistance varies also from time to time. That the accumulation of tension varies both in health and in disease has been demonstrated. And although the only variation of resistance that we have been able to identify has been a morbid variation, yet on the general principle that morbid variations are but exaggerations of normal variations, there can be no reasonable doubt that if the hypothesis is true at all, it is true that both the rate accumulation of tension and the amount of the resistance to its discharge are subject to variation within the limits of health.

To show how far from being fanciful is this doctrine of continuous resistance, a familiar illustration will suffice. The tension of the charged nerve-cell has been compared to that of the charged soda-water bottle, whose contents press uniformly and continuously against its sides. When the cork is drawn does the liquid flow from the bottle in an even continuous stream? It does not. It comes blobbing out in a succession of intermittent bursts. So that the slight resistance afforded by the mere narrowing of the bottle neck is sufficient to break up the continuous tension into an intermittent escape. Apart from other possible causes, may not the similar narrowing of the necks of the nerve-cells—the emerging fibres—be enough to produce a similar result?

PART I—*Continued*

FUNCTIONS OF THE NERVOUS SYSTEM

B

PHYSIOLOGICAL

CHAPTER III

MUSCULAR ACTIONS, THEIR CO-ORDINATION AND INHIBITION

WHILE the physical function of the nervous system is the redistribution of force, mainly by the production and regulation of muscular *action*, the physiological function of this system is mainly the production and regulation of muscular *movements.*

We read in books of anatomy that the action of one muscle is to flex a limb, and the action of another to extend it, that this muscle is a rotator and that an adductor; and it is a common exercise in the dissecting-room to pull on the tendon of a muscle and observe the effect on the limb. The biceps of the arm is often selected for this purpose, and every student knows that if an arm is lying supine, it can be flexed by pulling on the biceps tendon in the direction of its normal action. But every student knows also that when, by this means, he has raised the forearm to an upright position, it immediately falls by its own weight against the humerus. The arm becomes completely doubled up without the further action of any muscle whatever. This effect does not occur during life. Let the student lay his own arm supine on the table and then flex it. The first thing he notices is that he cannot use the biceps without at the same time using other flexors. By no effort on his own part can he isolate the action of this muscle and use it apart from its coadjutors. When, by the action of the flexors, the forearm is upright, it does not fall, it does not double up on the upper arm. There is no tendency for the arm to move further. Why this difference between the action in life and the action in the cadaver? Manifestly, because in life other muscles are in action besides the biceps—besides the flexors. Manifestly, in addition to the pull of the flexor muscles the extensors also are pulling, and so prevent any such sudden and unbalanced action. Seeing that the flexors are void of rigidity, this is the only possible explanation of the retention of the arm upright. What is true of this movement is true of every other. Every muscle has an antagonist which pulls in an exactly opposite direction; and *whenever a muscle is contracting, its antagonist is pulling in the contrary direction.* Were it not so, a part moved could not be maintained in any fixed attitude, nor arrested in any position except that of extreme contraction of one of its sets of muscles. But for the moderating and balancing action of the antagonist muscles, every movement would be a violent jolt from one extreme position to the opposite extreme—from extreme flexion to extreme extension, etc. A limb under the action of the nervous system would be like a horse whose driver could pull only one rein at a time.

We need not, however, be content with asserting that this *must* be so. We have the readiest and simplest proof that it *is* so. Let the reader lay his arm on the table as described above, and in order to render the action more conspicuous, let him grasp a heavy book in the hand, and then flex his elbow, holding the back of his arm meantime with the other hand. He will feel the extensor muscles *harden* in action. Still more conspicuous is the action of larger muscles. As you sit, extend your knee, and you will feel the muscles at the back of the thigh harden in action.

It is commonly supposed that the lengthening of the antagonist muscles is a purely passive process—that the lengthening muscles are merely stretched by the forceable separation of their ends. But this is not so. The lengthening of the one set of muscles is as much an active process as the shortening of the other, and is as directly actuated by the nervous discharge. Whenever opportunity arises, as it frequently does arise, not only from violent injury to, but from temporary pressure on, a nerve, of observing the action of a set of muscles when nervous afflux is withdrawn from its antagonists, it is found that the movements of the limb have precisely the same character as those artificially produced on the limbs of the dead. When one wakes in the morning to find that pressure has temporarily paralysed the musculo-spiral nerve, the first intimation that this has happened may very probably be a blow on the face from that very doubling up or flopping down of the arm which is produced on the cadaver by an unantagonised pull on the biceps. But in the living, the extensors of the elbow still retain their attachments. Why, then, are the flexors unantagonised? If the elongation of the extensors during normal flexion were a purely passive affair, this unbalanced action could not now take place, for the extensors still passively lengthen. If in normal flexion the antagonist muscles are merely stretched by the forcible separation of their ends, how is it that now when this forcible separation still takes place the movement is so defective? The cutting off of the nervous afflux has not only rendered impossible the normal contraction of the muscles, but their normal lengthening also is abolished, and therefore for normal lengthening the delivery of some nervous discharge is necessary. Moreover, the *hardening* of the extensors when a limb is flexed indicates the *activity* of the process.

An additional proof is afforded by other cases of paralysis. In lead palsy the extensors of the wrist and fingers are picked out by paralysis while their antagonists remain intact. What follows? The patient cannot extend his wrist or fingers. That is what we might expect. *But neither can he clench his fist.* The paralysis of extensors has spoilt the effect of the action of the flexors, clearly showing that in normal flexion the extensors also are at work. If the limb be artificially extended the fist can be closed.

At the risk of being tedious I will give another illustration. A patient with paralysis of both orbiculares palpebrarum muscles was told to close his eyes. He made a strong effort to do so, and in the effort he opened them wider. Here the normal action of the *opposing* muscles was unantagonised, and the movement that occurred was the opposite of the movement intended.

Here, then, we see the difference referred to in the opening sentence of this chapter, between muscular *action* and muscular *movement*. Muscular action is the action of single muscles. It is a purely physical phenomenon. It occurs in a living tissue it is true, but not necessarily in a living body, and it is as purely physical in nature as the movements of the joints. Muscular movement is another matter. A movement can take place only by the combined action of several muscles. When we deal with movements the action of individual muscles is disregarded. We no longer look on the body with the eye of the dissector. We care not what muscles contribute to the movement. We contemplate the organism as a whole, and regard, not the action of this or that *muscle*, but the movement of this or that *limb*. We have risen to a higher plane of observation, and regard the matter in a more comprehensive view. Muscular action may be studied in the phenomena presented by a single muscle or part of a muscle isolated or removed from the rest of the body. Muscular movement has no meaning except as the movement of one part of the body *with reference to the remainder*. The unit of muscular action is the muscle. The unit of movement is a pair of antagonistic muscular groups.

Every movement requires, as we have seen, the combined action of at least two opposing muscles, and it will be obvious without illustration that most movements require the combined action of many muscles. We have now to notice that the actions of the several muscles must be combined in definite ways. Suppose your arm is bent and you proceed to bend it more. Both flexors and extensors must pull, but the flexors must give the stronger pull; and not only must their pull be stronger, but it must be stronger by just so much as is necessary to ensure even, orderly, sufficient and not excessive movement. If the pull of the extensors is much too strong, the movement will be in the wrong direction—will be one of extension instead of flexion. If it is too strong without being stronger than the flexors, some of the force will be wasted, and the movement will be too slow. If the extensors don't pull strongly enough, the arm will be bent too suddenly and too far. It has been recommended above that in order to render the action of the extensors during flexion more conspicuous, the hand should hold a weight. To raise the weight the flexors must act more strongly, and when the flexors act more strongly, the action of the extensors also is stronger. Hence it appears not only that the lengthening of the extensors is an active and not a passive process, but that the force or amount of their action must bear a certain ratio to the force of the flexors. In other words, for the movement to be properly performed, not only must both sets of muscles pull, but *the force of one pull must be duly proportioned to the force of the other.*

Next it is to be noticed that both sets of muscles must start into action at the same moment, and together cease to act. For if one set has a start of the other, the movement will begin with an awkward jerk, which will be suddenly arrested when the antagonists begin their work. And if one set ceases before the other, a similar jerk will terminate the movement. So that for an efficient and normal movement the actions of the several muscles must be so combined that they start and cease simultaneously. In other words, *the time of action of the one set must be duly proportioned to the time of action of the other.*

Similarly it will be obvious that the extent of the elongation of the lengthening muscles must be precisely equivalent to the extent of the contraction of the others, or the movement will fail.

Hence it appears, that for the due performance of every movement whatsoever there must be action of a plurality of muscles determined in a plurality of ways; that the forces, times and extents of the action of one set must bear a due proportion to the forces, times and extents of the action of the other set. When muscular actions are thus combined in due proportion they are said to be CO-ORDINATED; and Co-ordination may be defined as *combination in determinate ratio.*

Co-ordination, therefore, is not a special function located in an isolated portion of the gray matter, and interfering only on occasions and in particular movements. It is an indispensable constituent of every movement whatever, and is a function of every portion of gray matter. Co-ordination has indeed a far more extensive *rôle* than that usually assigned to it.

When I rise from my seat I do so by the action, combined in due proportion, of innumerable muscles. I walk across the room by the action also, co-ordinated, of many muscles. My arm is raised to the bookcase, and my hand grasps a book by similar actions similarly co-ordinated; and by the same means I return to my seat. Now notice that all these movements, composed as they are of co-ordinated muscular actions, must themselves be co-ordinated together for the act of fetching the book to be successful. The closer up to the bookcase that I walk, the less far do I need to stretch my hand; in other words, the *extent* of the reach must be duly proportioned to the *extent* of the walk. It is no use stretching out my arm and grasping before I am within reach of the bookcase, nor will the action be successful if I defer these movements until I am half-way back to my seat. In other words, the movements must succeed each other in proper order and at proper times—the *time* of one movement must bear a due proportion to the *times* of the others. The movements must be co-ordinated in time. Hence not only is there a co-ordination of muscular actions into movements, but there is also a co-ordination of movements into acts; and a little consideration will show that a similar operation on a still higher level combines acts into conduct.

That the simultaneous action, in duly proportioned extents and forces, of all the muscles that take part in a movement, is owing to the action of the nervous system, is unquestionable and is unquestioned. When the nerve that enters a muscle is divided, the muscle no longer takes part in the execution of movements. When a nerve-trunk is divided, all the muscles that it supplies cease to take part in the execution of movements. When the course or the divided ends of a nerve are stimulated, all the muscles that are supplied by that nerve are thrown into action. So much is agreed and so much is determined. But this is a very small advance towards the solution of the problem with which we now have to deal, which is not merely, *Does a process in the nervous system produce muscular action?* The problem that we have to solve is, *What is the nature of the process in the nervous system which produces the simultaneous action, in duly proportioned extents and forces, of several muscles?* How does the nervous system contrive to produce absolutely simultaneous action of many muscles, and how does it contrive to effect that all these actions shall be duly proportioned in their forces and extents? To this question no answer has as yet been given. The question itself has, as far as I know, never been asked; and it is therefore the more necessary that in searching for the solution we should make as sure as possible at each step that we are on solid ground before proceeding further.

With regard to the amount, and even the existence, of the currents of force in the nerves, we are in this peculiar position: that we have no direct means of measuring their strengths, nor even of observing their passage. From experiments in the laboratory and from the effects of injury and disease we infer that currents of force do pass through the nerves, and that the strength of these currents is extremely various, but we cannot submit the discharge to direct observation. Practically, our only means of judging of the arrival of a current of force in a limb is by a contraction of the *muscles* of the limb. When such a contraction takes place, we suppose that a current of force has been delivered into the muscles along the nerves from some distant part of the body. Nay, we go much further than this. We are in the daily habit of inferring that the force, duration and extent of the muscular contractions depend on and correspond with variations in the nervous discharge that is carried to and delivered into the muscles. This assumption is latent in every statement that a nervous centre "represents" a movement. Take away the implied doctrine that the nerve-currents issue from the centre in the proper amounts and in the proper combinations for producing such and such muscular actions, and the "representation" of movements in nerve-regions becomes an expression without meaning. Yet although this assumption is daily and hourly made by those who deal with the localisation of movements in nerve-areas, it remains a pure assumption, for which they have no warrant beyond the settled conviction that if it is not true it ought to be. Nevertheless, the assumption, though unproved, is susceptible of proof, and therefore ought not to be accepted without it.

Every movement requires, we have seen, the action of at least two muscles for its performance. The action of these muscles is set up by nervous discharges. It is to be proved that the amount of the nervous discharge is proportionate to the amount of the muscular action. Let us suppose that the amount of the muscular action is not proportionate to the amount of the nervous discharge. In that case, a movement of given extent, produced as it must be by the action of several muscles, will be set up by any set of discharges whatever delivered into those muscles. And conversely, whatever discharges are delivered into the muscles, the same extent of movement will result. In other words, every part of the body is capable of movement to one fixed extent and to that extent only. But as a fact, we know that every part of the body can be moved to any one of innumerable positions between the position of extreme shortening of one set of muscles and the position of extreme shortening of the antagonistic set. The finger, for instance, can be moved to any position intermediate between that of extreme flexion and that of extreme extension. The conclusion at which we have arrived is therefore inconsistent with fact, and hence the hypothesis with which we started must be erroneous. And this hypothesis was that the amount of muscular action was not proportionate to the amount of the nervous discharge which set that action going. Hence it appears that the amount of action of a muscle is proportionate to the amount of the discharge which is delivered into it. It follows as an obvious corollary that the larger muscle is represented in the larger centre; in other words, the size of the centre is in general proportion to the size of the muscles that it represents.

It is therefore justifiable and proper to speak of nervous discharges in terms of muscular actions, and to infer from the variations of muscular actions, corresponding variations in the nervous discharges to which those actions are owing. The settlement of this preliminary and general problem renders it possible to advance to the next and more special problem, which is, *What are the elements of the nervous discharge that determine respectively the simultaneity of the muscular actions, and the force, rapidity, and the extent of the movement they compose?*

As to the simultaneity of the muscular actions, there can be no doubt whatever that they are due to the simultaneity of the nervous discharges. There is experimental evidence on the one hand of nerve-muscle preparations, which shows that the action of a muscle is practically simultaneous in commencement, duration and ending with the delivery into it of an interrupted current of force. And there is on the other hand the evidence of localising experiments, which shows that normal movements—that is to say, muscular actions co-ordinated in simultaneity—occur when a single area of gray matter is discharged; and which demonstrate further that the simultaneous commencement, duration and ending of these muscular actions is determined by the simultaneous issue from the area of gray matter of a current of force to each muscle concerned in the movement. The results of such experiments leave no uncertainty as to the proximate cause of simultaneity of muscular actions. It is determined by the simultaneity of nervous discharges.

The *force* of the movement is due, as will appear from the preceding argument, to the *amount* of the nervous discharge. For the same argument that applies to separate muscular actions will apply, *mutatis mutandis*, to the same actions when combined together into movements. It does not require a repetition of the argument to show that when a heavier weight is lifted, the increased muscular exertion requires and indicates a more powerful innervation of the muscles concerned than when a lighter weight is lifted.

The *rapidity* of a movement is evidently due, other things being equal, to the amount by which the action of the one set of muscles exceeds the action of the other, or to put it more generally and more accurately, the rapidity depends on the amount by which the action of the moving muscles exceeds the resistance to the movement. Let me explain. Suppose I lift my hand to my head, the rapidity of the movement depends on the amount by which the action of all the lifting muscles exceeds the pull of their antagonists together with the weight of the arm. Suppose I am lifting a brick by a string, the rapidity of the movement depends on the amount by which the pull of the lifting muscles exceeds the pull of their antagonists, plus the weight of my arm, plus the weight of the brick. This is a problem in mechanics, and does not require physiological demonstration. But demonstration is forthcoming. Suppose the string breaks, instantly the arm jerks upwards,—that is to say, the rapidity of the movement is greatly augmented. It is augmented because, the pull of the lifting muscles remaining the same, the resistance to their action is diminished; in other words, the excess of their action over the resistance to the movement has augmented, and the rapidity of the movement has correspondingly augmented. And we have seen that the amount of the pull of the moving muscles is determined by the amount of the nervous discharge. Hence the rapidity of the movement is determined by the amount of the nervous discharge into the moving muscles.

The *extent* of a movement—that is to say, the space through which a part moves—depends also on the nervous discharge, but on a different element in the discharge from those hitherto considered. It is manifest that for a part to remain at rest, the pulls of all the muscles concerned in moving it must be so proportioned that the pull of any one must exactly counterbalance the pulls of all the rest, plus or minus the weight of the part and any other outside influence tending to move it.

The extent of a movement will therefore depend on the time at which this equilibrium of pulls is substituted for the superior pull of the moving muscles in which the movement depends. Now since the ratio of the pulls is determined by the ratio of nervous discharges, a change in the ratio of the pulls must be determined by a change in the ratio of the nervous discharges. The arrest of a movement depends, therefore, on the moment at which a given combination of nervous discharges is substituted for a previous combination. It is manifest that the initiation of a movement is similarly conditioned. Hence the *extent* of a movement is determined by the duration of a certain combination of nervous discharges.

The simultaneity, the force, the rapidity, the extent of muscular movements, are therefore determined by factors of the nervous discharge into the muscles.

The simultaneity of muscular actions is determined by the simultaneity of the nervous discharges. The *force* of a movement is determined by the *amount* of the discharges. The *rapidity* of a movement depends also on the *amount* of the discharges; and the *extent* of the movement depends on the *duration* of the discharges. What, we have to ask, is the disposition of nerve-tissue that determines these factors in the discharge, and so produces a given movement?

Let us suppose, and the supposition is in harmony with the observations of anatomists, that every muscle is connected by its nerve with a group of nerve-cells. Then, when these nerve-cells discharge, the muscle contracts; and the force and duration of the nervous discharge determine the force and duration of the muscular contraction.

Every muscle that is concerned in the movement we are studying is connected in this way with a group of cells. For the movement to take place, it is necessary that all these groups of cells shall begin, continue and finish, discharging simultaneously. By what mechanism can this be effected? Let us suppose that each such group of cells is connected by a nerve-channel, with one central group common to them all, but not connected directly with a muscle; and let us suppose this central group to discharge. What will happen? The discharge from the central group of cells will flow through the channels to the other groups, and if of sufficient intensity, it will set each of these groups discharging. The discharge from the central group will reach the other groups simultaneously, and will set them all simultaneously in action. So long as the central group continues to discharge, so long will the subsidiary groups discharge. The moment the discharge of the central group ceases, the discharge of all the subsidiary groups will cease. Such an arrangement will, it is obvious, account for the simultaneity of the actions of any number of muscles. Will it secure also the due proportion of the force of each muscular action to the forces of the others? Let us see. The force of a muscular action depends on the amount of the nervous discharge into it. And the amount of the nervous discharge from a cell depends on the magnitude of the disturbing force. In the case in question, the disturbing force is a discharge from another centre delivered through a nerve-channel. Now when a number of currents issue from one discharging region, the magnitude of each current will depend, while the discharge is constant, on the calibre of the channel that carries it. When a number of pipes lead from the bottom of a cistern, the amount of water discharged by each pipe depends on the calibre of the pipe. Hence if the calibres of the nerve-channels from the central group to the subsidiary groups are properly proportioned to one another, the discharges of the subsidiary groups will be properly proportioned, and so will be the muscular actions that result from them.

The force and the rapidity of a movement depend, as we have seen, on the amount of the discharge into the muscles; and the magnitude of the discharge from the subsidiary groups of nerve-elements depends, as just shown, on the magnitude of the discharge from the central group.

The extent of the movement again depends on the duration of the discharges from the subsidiary groups, which in its turn is governed by the duration of the central discharge. Hence all the conditions of associated discharge that produce a muscular movement can be brought about in the way suggested by the discharge of a single central group of nerve-elements.

Such a group of nerve-elements is called a NERVE-CENTRE. By a nerve-centre we mean therefore a group of nerve-elements so arranged that their simultaneous discharge produces a co-ordinated muscular movement. The movement so resulting is said to be *represented* in the centre.

The particular movement that results when a nerve-centre discharges depends, as we have seen, on the proportional capacity of the nerve-channels issuing from the centre. The nerve-fibres which constitute these channels are not liable to alter in calibre when once their growth and organisation are complete. Hence it appears that a single nerve-centre represents a single movement, and only one. For every separate movement a separate nerve-centre is required.

It has been shown that the centre which represents the movement of flexing the arm, issues its discharge through the subsidiary groups of nerve-cells, both to the flexors and the extensors. Similarly in the movement of extending the arm both the extensors and the flexors are active. Let us suppose that the discharge issued to the flexors is ten times the magnitude of that issued to the extensors. And let us further imagine that there is a second centre which issues its discharge to the cell-groups representing the various muscles of the arm in inverse proportion to the discharges of the first centre,—that is to say, ten times as much to the extensors as to the flexors. The resulting movement will be one of extension, and it will be carried out through precisely the same muscular cell-groups as the movement of flexion. The same reasoning will hold good for all other movements in which these muscles are engaged. So that for every muscle a single primary muscular cell-group will be sufficient—all movements into which the action of that muscle enters being conditioned by the diverse proportion of the discharges which that cell-group receives. It will be evident that such an arrangement would effect a vast saving in the amount of nerve-tissue employed in effecting movements. To set a muscle in action requires a considerable expenditure of nervous energy. To set a group of nerve-cells in action requires a comparatively insignificant amount. So that while the primary cell-groups must be of considerable size, the nerve-centres need be but small. If a different set of primary cell-groups were required for every movement, a man's head must be relatively as large as a tadpole's.

Since every muscle takes part in many movements, and every movement requires a separate centre, it follows that every muscle must be represented in many different centres.

Again, since every movement requires the co-operation of at least two muscles, it follows that no nerve-centre above the primary muscular cell-groups represents a single muscle.

The properties of a nerve-centre are therefore twofold, and the two sets of properties are profoundly different. The first set of properties is that we have just considered, of issuing such amounts of force simultaneously in such directions and in such proportions to such muscles that a certain definite movement ensues. The other set of properties are those of starting into action at a given moment and ceasing to act at another given moment, so regulating the initiation, duration and extent of the movement. The first function is manifestly intrinsic to the centre itself. The issue of force in certain directions and in certain proportions is a consequence of the structure of the centre, and there is nothing in the constitution of the centre itself to prevent this action going on to utter exhaustion. The other function is very different. To start the centre into action it is manifest, both from what was said in the previous chapter and from the general laws of physics, that some force must impinge upon the centre from a source external to itself. The first law of motion is as true of nervous molecules as of planets. A centre at rest will continue at rest, and if in action will continue to act in the same way unless acted on by some extraneous force. Both to start the action and to arrest it some influence from outside the centre is necessary.

We have seen in the previous chapter that the initiating impulse comes always, directly or indirectly, from the periphery of the body and so from the outside world. In the case of a blink of the eyelids from the impact of a speck of grit on to the eyeball, the impulse that starts the centre into activity comes directly from the outside world. It is an action of the environment on the organism producing a direct reaction. When we dodge to avoid a missile that we see coming towards us, the reaction is less direct. The nervous-current from the retina has to pass through other centres before it reaches the motor arrangement which carries out the sudden stoop. If a man leaves his home to escape an interview with an unwelcome visitor, of whose arrival he has heard by the post, the influence that starts the movement of walking travels by a still more circuitous route from its point of arrival at the retina to its termination in the locomotor apparatus. And when a man insures his life at his wedding, so that his children may be provided for at his death, the necessary actions are set going by currents starting from the highest centres, and resulting from an arrangement of those centres that has been in course of formation for years under the influence of impressions on the organism of great complexity and innumerable multitude.

That a stimulus is necessary to set the centre in action all will admit, but that another is necessary to terminate the action will be to many a new proposition. But yet it is sufficiently obvious. It is no more possible that the centre can stop of its own accord (unless, indeed, it be entirely exhausted) than that it can start of its own accord. For a centre to cease acting from sheer exhaustion is so extremely rare, that it virtually never occurs in the normal organism. Practically, it never happens that we are so exhausted by the performance of a particular movement that it is absolutely impossible to perform it once more. Whenever a movement ceases, therefore, or, what is the same thing, whenever a movement is superseded by another, the centre which represents the arrested movement must have its action arrested by some means or other. What is this means?

Reference to the previous chapter will show that the specific function of nerve-tissue is the storage and transmission of force. There it was shown that the nerve-cells are the seats of explosions of force, the nerve-fibres the channels for currents of force. No other physical function is ascribed to nerve-tissue; no other physical function is known. As at present advised, and unless the contrary is shown, we must therefore conclude that the action of nerve-centres is arrested by a modification of the same process that sets the action going—by the impact of an extraneous force. To such a doctrine there can be no objection on the score of *à priori* improbability. The nerve-currents are known to be undulatory in form, and the nullification of one set of waves by another similar set is a familiar occurrence in various regions of physics. The phenomena of the interference of waves of light and of sound are cases in point. One set of sound-waves may so act on another set as to result in silence. One set of ethereal waves may so act on another set as to result in darkness; and, similarly, one set of nerve-waves may so act on another set as to result in nullifying their action, whatever it may be. Hence, if a centre is put in action by one nerve-current, it is easy to conceive, nay, it is a necessary consequence of the constitution of nerve-tissue as thus far expounded, that it should be liable to be put out of action by another nerve-current.

Let us take a very simple case. Take a case of reflex action, such as the sudden closure of the eyelid when the eyeball is touched. In this case the origin of the impulse which sets the centre in action is obvious. It comes from the periphery, and is set going by the impact of a force from the outside world on the surface of the organism. Starting from the conjunctiva, the current of force travels inward to the centre which actuates the orbiculares muscles, sets the centre in action, and the movement follows. But now comes a most notable phenomenon. The single touch of the eyeball starts an action of the centre which actuates a single blink of the lids, and then the action ceases, and the lids are again opened. If the touch is intense or is repeated, there may be several blinks in response to the irritation, but when the irritation ceases, the movement also ceases. Why does the movement cease on the suspension of the irritation? There is nothing in the constitution of the centre itself to cause the arrest of its action when once it has been set going by the impact of an extraneous force. Reference to the conclusions of the previous chapter will show just the contrary to be the case. There it was shown that *a discharge once begun tends to get stronger*, and *a discharge once begun tends to spread.* But it has not been shown that a discharge once begun tends spontaneously to cease, until the centre fails to act from sheer exhaustion. And in the present case, there is no question of the centre being exhausted, for another similar stimulus immediately produces another similar action. Yet we find that as a matter of fact the centre does cease to act the moment the stimulus ceases to reach it. Before drawing the obvious inference from these statements, let us add from the last chapter a further statement which will render still more obvious the conclusion that I seek to establish. It was there shown (p. 45) that every part of the nervous system is at all times the seat of continuously flowing currents of force. "Along every nerve-fibre gushes of force continually succeed one another, as waves of blood pass through the arteries. Every nerve-cell is, as it were, a heart, which receives the current flowing into it and discharges it with increased impetus." If this be so, and if the centre for the movement of blinking is, in common with all other centres, continually receiving disturbing shocks of greater or less magnitude, how is it that it is not continually discharging and so keeping the eyelids continuously closed? Even granting that many of the impinging shocks may be too feeble to upset the equilibrium of the centre, yet as the centre increases in instability (as it does by rest) a time must come when even extremely feeble shocks are sufficient to set it in action, and once in action it must, for aught that we have so far shown, continue in action until exhausted. But this it does not do. Hence there must be some element in ordinary nervous action that we have not yet taken account of. The nature of this element will be obvious from what has been said. It is the element of CONTROL. Every nervous centre is at all times subject to continuous control or inhibition; so that while its intrinsic tendency is ever to discharge, this tendency is continuously counteracted by an extrinsic influence which curbs it into quietude. Just as, in molecular physics, atoms are maintained in a condition of mobile equilibrium by the opposing forces of attraction and repulsion; just as in molar physics the planets are maintained in their orbits, that is in mobile equilibrium, by the opposition of attraction to their own inertia, so the nerve-centres are maintained in a condition of mobile equilibrium by the opposition of the inhibition exercised upon them, to their own inherent tendency to discharge. A review of the facts of muscular action and nerve-function has led us directly to this hypothesis, and, however startling it may be to neurologists, I will ask them to suspend their fulminations against it until its consequences and implications have been displayed. Meanwhile, I will ask them to remember that by the frequent use of the phrase Loss of Control (indeed I have heard an eminent alienist speak of an "outburst of loss of control"), many of them have already surrendered the whole position. For control to be lost, it must first be present; and if present in some centres, why not in all? The hypothesis already exists therefore, and is already largely accepted, and it is of such indispensable necessity to a comprehension of the physiology of the nervous system, that we may say of it as the French philosopher said of the Deity, if it did not exist it would be necessary to invent it.

Very little consideration is required to show that to have its nervous centres in a state of mobile equilibrium is vastly more advantageous to the organism than to have them disposed in any fixed arrangement. In the first place, a mobile equilibrium is far more stable, in the sense of being less easily destroyed, than any fixed disposition. The phenomena of the gyrostat are familiar illustrations. A spinning top remains upright on its point without any external support, in spite of the inclination or the movement of its supporting surface, and in spite of deflections of its axis from the perpendicular, even of considerable magnitude. The same top if not spinning cannot be balanced on its point for an instant, and even, if by superhuman patience and steadiness it were to be so balanced, the slightest breath of air would at once cause it to fall.

While, on the one hand, the moving equilibrium presents a maximum of stability, on the other hand, paradoxical as it may appear, it presents a maximum of plasticity,—that is to say, while it is with difficulty destroyed, it is modified and altered within limits with the greatest ease. Consider, for instance, the example of mobile equilibrium presented by the circulation of the earth in its orbit; so delicate is its balance that the movement of another planet, hundreds of millions, thousands of millions of miles distant, produces a sensible perturbation in the path of our earth. It is as sensitive to the presence of other bodies at these inconceivable distances, as the magnetic needle to the presence of an iron bar in its neighbourhood; another combination in mobile equilibrium. Suppose now that the earth, instead of circulating freely in mobile equilibrium, were fixed to the sun by a rigid rod; if all the other planets were massed together and brought within half a mile of the earth's surface, they would produce no perceptible alteration in its position in space. These two examples will be sufficient to show how susceptible an arrangement in moving equilibrium is to external influences, how readily and completely it returns to the normal after disturbance, and how difficult it is to break down. When it is remembered that the two fundamental properties of the nervous centres are those of being readily disturbed from without, and of readily resuming their *status quo ante;* and when it is further borne in mind that this susceptibility to disturbance must be united with great resistance to disintegration, it will be seen how immensely advantageous it must be to the nerve-centres to be in that state of mobile equilibrium, in which these almost antagonistic qualities are so prominent and so closely united.

Granting that every motor nerve-centre has its intrinsic tendency to discharge continually under the control of some extrinsic influence, the next question is, Whence is this influence derived?

Two hypotheses are possible. Either there may be one or more portions of gray matter specially reserved and set apart for the purpose of producing this continuous inhibition of all motor centres, thus constituting special inhibitory regions, or the functions of inhibition may be carried on by the ordinary motor centres concurrently with their more generally recognised function.

Of the existence of a single centre, whose function is inhibition and nothing else, there is no evidence, and from the nature of the case there could not but be evidence if such a centre existed. Suppose a sudden lesion, such as a blood-clot, destroyed such a centre, the effect would be that the whole control would be instantly removed from every motor centre in the gray matter, and the consequence would be such a terrific spasm of the entire body as the severest epileptic fit can give us but a faint and ineffectual idea of; the spasm would at once arrest the breathing, and speedy death would follow. Such a malady is not clinically known, and we may therefore be sure that if there be a general inhibitory centre, it has never been destroyed by hæmorrhage, nor by any sudden lesion. Neither is there evidence of such a centre being destroyed by a gradually invading lesion. In that case there would be excess of movement gradually increasing to universal spasm, and ending in death either by exhaustion or by arrest of breathing as before. Now something corresponding to this description does actually take place in chorea, and it is at first blush conceivable that chorea might be due to the morbid weakening of a general inhibitory centre, but such an hypothesis will not bear investigation; for the movements of chorea, although affecting all parts of the body, are manifestly not due to the discharge of all motor centres. Apart from their elaborate character there is the fact that they are essentially *a succession of different movements,* and indicate therefore a succession of discharges of different centres. Whereas the weakening of our universal inhibitory centre must produce a simultaneous discharge from all centres.

The inhibition of motor centres must therefore be actuated not from a single store, but from many different places; and the next question is whether there are regions of nerve-tissue specially set apart for the origination of inhibition alone, or whether this function is exercised concurrently with others? It may be said at once that the balance of the evidence is overwhelmingly in favour of the latter hypothesis. Neither in experiments on animals nor in the experiments exhibited by disease and accident has there been any instance of a destruction of gray matter producing primarily an outburst of movement; and it is in the highest degree improbable if a number of centres existed, and by hypothesis the number must be large, whose functions were purely inhibitory, that no one of them should ever have been singled out for destruction by experiment, by accident, or by disease. Hence we are driven by a series of exclusions to the opinion that the state of inhibition which universally obtains throughout the motor centres is maintained by centres which exercise this function concurrently with others.

Turning our attention from the source of inhibition to its nature, we are unable to avoid the conclusion that we are now regarding another aspect of the phenomenon that we have already dealt with under the title of nervous resistance. It has already been found that every nerve-element in discharging has to overcome a resistance which breaks the continuity of its accumulation and renders its escape intermittent. It has further been found that the intensity of this resistance is subject to variation. It seems reasonable to suppose that, just as the physical process of the nervous discharge, when viewed in the aggregate as a physiological process, is the motor of muscular movement; so the nervous resistance when raised to the same power is the physiological factor inhibition.

The action of nerve-currents on nerve-centres being a purely physical process, it is obvious that the manner in which the centres act on one another must depend on the disposition in which they are arranged, and our first task must be to discover the method of this arrangement. For the purpose in view, the few data furnished by anatomy are far too few and of too coarse and crude a character. The only means of investigation that we at present possess sufficiently searching and delicate for our purpose is that which, in the hands of Hughlings Jackson, Hitzig and Ferrier, has been the foundation of modern neurology—it is the observation of movements. If, as has been stated, the bodily movements are conditioned by nervous discharges, then the mode of occurrence of movements must be an index to the arrangement of that nervous tissue by whose action they are produced. The only way to get at a knowledge of the intimate arrangement of nerve-centres is by systematic study of the movements which they actuate, and which derive their character from the mode in which the centres are arranged. It can scarcely be too often reiterated that the study of movements is the only means by which we can gain any insight whatever into the working of the nervous system, and it is scarcely possible to over-rate the importance to neurology of a systematic study of bodily movements, both normal and morbid.

CHAPTER IV

MOVEMENTS

MOVEMENTS admit of classification on two principles: one according to the character of the movement, the other according to the part of the body concerned in it; and it is found that the classifications founded on these totally different principles coincide in a very remarkable manner.

Viewed with regard to the region of the body concerned in them, movements are divided into central and peripheral; and I would ask the reader's special attention to the meaning here attached to these terms, which are here used somewhat arbitrarily. By a central movement is meant, generally, a movement of the trunk. By a peripheral movement is meant, generally, a movement of the digits, mouth and eyes; and the remaining parts of the body are classed in an intermediate position, and in one which approximates to the central or to the peripheral according, generally, to the size of the part moved and the size and individuality of the muscles concerned in the movement. This, I say, is the general rule, but it is not accurately true in every case unless we compare parts that follow one another in physiological series. It is accurate to call the movements at the shoulder more central than those at the elbow; those at the elbow more central than those at the wrist; and those at the wrist than those at the fingers. But it is not accurate to call the movements at the ankle more peripheral in the sense here used than those at the elbow. The movements at the ankle are not very definitely comparable with those at the elbow, and their relative rank cannot therefore be very definitely assigned; but they can be definitely compared with those of the knee, and can be definitely said to be more "peripheral." Similarly the movements of the larynx as a whole are more central than those of the vocal cords; those of the latter are more central than those of the palate; those of the palate than those of the tongue; but we cannot say definitely whether the movements of the tongue are more peripheral than those of the digits; nor as a rule do we require to do so. In the future consideration of movements we shall find that we require as a rule to compare parts that follow one another in the same physiological series, and only rarely the individual movements of one series with those of another; though we may often compare the speech series as a whole with the arm series, or the arm with the leg. Movements of the tongue, again, are more peripheral than those of the jaws, movements of the jaws than those of the neck, and those of the neck than those of the back. The trunk, and especially the great muscles of the back, may be regarded as the starting-point from which each physiological series radiates, and their movements are therefore denominated the central movements. Closely allied to them are the movements of the neck and jaws at the one extremity, and of the hips and thighs at the other. Some movements of the eyes are also "central" in character, viz. those of convergence and divergence and the upward movement. The side-to-side movements are of a much more "peripheral" character. Movements of the arms at the shoulder are considered much more peripheral than those of the legs at the hips, and as we recede from the trunk and pass down the arm to the digits, the movements become of course more and more peripheral. It will be observed that a more peripheral movement is not *necessarily* a movement of a part further from the trunk, though it usually is so; but it usually means a movement carried out by smaller muscles, and it always means a movement less closely associated with the great trunk system, and one involving the action of more *individualised* muscles—of muscles whose action is less bound up with that of other muscles.

Such is the regional classification of movements—a classification in which there are no abrupt divisions, in which the movements of the central class merge into those of the peripheral class by insensible gradations, but in which the movements at the opposite ends of the scale present differences that are extremely wide, numerous and important. What these differences are, we shall ascertain by considering the different *characters* of movements.

The term "movement" is here used in a technical sense, and means *any set of co-ordinated muscular actions.* If I pull open this drawer, my limb performs a movement in the colloquial sense. If I pull the handle of this other drawer, which is locked, my limb goes through no movement in the colloquial sense; but since the pull is the outcome of co-ordinated muscular action, it is a movement in the technical sense in which that term is here understood. If I rise from my chair and stand upright, the change of position is a movement in the colloquial sense; but if I stand still, the posture is maintained by the co-ordinated action of many muscles, and the maintenance of the steadfast position is a movement in the technical sense, although there is no motion, and although colloquially there would be said to be no movement. Hence in physiology there may be movement where there is no motion, and there may be motion—*e.g.* action of a single muscle—which does not amount to movement. The term as used here has attached to it a strictly technical and arbitrary connotation, and must be understood in the sense in which it is now defined.

Continuity and Intermittence

During normal life the whole of the voluntary muscles are continuously active. Even during the profoundest sleep no voluntary muscle is ever completely relaxed. The truth of these statements is demonstrated by numerous facts. When the tendon of a muscle is cut across, the muscle immediately and invariably shortens, and remains shortened. Similarly, when a joint is dislocated or a bone broken, every muscle whose ends are approximated by the altered relation of the parts takes advantage of this approximation to effect that shortening towards which it is continually striving. The most convincing proof of the continuous action of muscles is, however, seen in the behaviour of a limb that is paralysed in such a way that all its muscular action is abolished. Paralysis, even when it is complete in the sense that all voluntary motion is lost, does not necessarily involve the loss of muscular action. In the majority of cases of paralysis muscular action is, on the contrary, excessive, and is shown in undue rigidity of the limb. But in the early stage of most paralyses, and throughout the course of complete infantile paralysis, muscular action in the paralysed limb is altogether abolished; and in the difference between the state of a limb under such circumstances and its state in healthy rest, we have irrefragable evidence of the continuous action of the muscles in health, even during the most profound repose. In the healthy limb, not only are the muscles always firm to the touch,—a state of itself indicative of some tension,—but whatever the attitude of the limb, it is never such as would be produced by the action of external forces solely. There is, between the attitude actually assumed by a healthy limb and the attitude that it would assume if deprived of all nervous influence, always some difference which indicates the existence of some residuum of muscular action in the limb. This is the difference between the attitude of a living limb under given circumstances and the attitude under the same circumstances of the limb of a cadaver after the cessation of rigor-mortis. Such a limb, or the limb affected by infantile paralysis, flops about in a flail-like manner under the influence of gravity whenever its point of support is moved. Such flail-like movements not only do not occur in the healthy body, but they cannot by any possibility be simulated by a healthy person. This inability to simulate these movements demonstrates beyond question that the conditions for their production are wanting

—that the complete absence of muscular action which alone renders them possible is wanting—that a certain residuum of muscular action is present.

It is further to be noticed that while this continuous muscular action, which we call "tone," is always present and is everywhere present, it is not equally present. In some parts of the body it is so conspicuous that it cannot be overlooked, while in others it is so inconspicuous that experiment is necessary to prove its existence. The parts in which it is conspicuous are the great muscles of the trunk, the hips, the neck, and the jaws—are, in short, those concerned in "central" movements. We cannot make the trunk of a cadaver assume the position that the body takes in life. We cannot support it in a standing, nor even in a sitting position. The head lolls about in a characteristic manner, falling hither and thither from the slackness of the muscular stays; the jaw drops. In these differences in the attitudes of the living and the dead we see proof of the existence in the living of that continuous muscular action which is necessary to maintain the erect position to keep the head supported and the jaws closed. But in the parts whose movements are peripheral—in the hands and feet and mouth—the position assumed after death, when all nervous influence and all muscular action are withdrawn, is not markedly different from the position in rest during life; showing that in these parts the muscular tone is far less conspicuously present during life than in the others.

If from that continuous and ever-present action, which we call the "tone" of muscles, and in which co-ordination is inconspicuous, we pass to those actions which are occasional and interrupted, we find that while in all parts of the body interrupted movements occur, yet in the central parts the movements are of a flowing and quasi-continuous character, rising gradually out of and merging gradually into contiguous movements, while in the peripheral parts the interruptions are abrupt and the intermittency is strongly accentuated. The movements of one set are tonic in character, those of the other approximately clonic. This difference is one of great importance. The continuous movements are closely allied to, and are indeed evidently a modification and development of, the muscular tone. The interrupted movements are separated from mere tonicity by a much wider interval. It is evident that the enduring muscular action which keeps the head upright—a movement which is so nearly constant that we lose consciousness of it, and which does not quite cease even when we are lying down, is much more closely allied to that quite constant action which we call tone than are the movements of the mouth in talking, or the movements of the hands in knitting. When we turn or bow the head, the movement evidently does not start from a state of rest; it is a transition from a previous movement —the "movement" of keeping the head erect. And when the turning movement is over, the moving part does not subside into a state of rest, it merges again into the "movement" that maintains the erect position. As soon as from a standing posture we start to walk, the trunk executes those swaying side-to-side movements which maintain the centre of gravity over the shifting area of support. But again these movements do not start *ab initio*. They are mere continuations of the previous "movement" of maintaining the erect posture, and their cessation is a cessation of motion, but not a cessation of movement. How different is the case when we begin to speak or to write. Here the muscles start from a condition of rest which is as complete as the residual muscular tone will allow, and when the movement is over it admits of no gradual cessation, it falls abruptly into a state of repose. The closure of the jaws in eating is evidently but a slight modification of the continuous action which keeps them always closed; and this action itself is one which some would class as mere muscular tone, while others would consider it a definitely co-ordinated muscular action. In all the central movements, whether of the trunk, neck, or hips, we see the same quasi-continuous character—the same origin out of a previous movement and fusion with a subsequent movement—the same want of abrupt limitation. In all peripheral movements, whether of the digits, lips, tongue, or feet, we see characters just the opposite; we see a sudden origin, a rapid subsidence into a condition of repose, or abrupt change into a totally different movement. In intermediate positions the movements are proportionately intermediate in the characters now under review, as a little consideration will show.

Precision

The next difference that we have to notice between central movements and peripheral movements is one of a more conspicuous character: it is the difference in precision. While the central movements are vague and inexact in their limitation both in time and space, progress towards the periphery is progress towards movements of greater and greater exactitude, and when we reach the extreme periphery we find the digits and the articulatory apparatus capable of executing movements whose precision is positively marvellous. If we compare the movements of the trunk-muscles in such an exercise as rowing or punting, with the more peripheral movements of the arms in the same occupations, the difference in precision, though considerable, is not sufficiently so to attract attention; but if we compare such central movements with the peripheral movements of the draughtsman or the violinist, the immense difference is at once apparent. Whether the oarsman leans an inch or a couple of inches further forward or further back is not only a matter of little importance with respect to the efficiency of the total action, but is a matter which is not easily determinable by him. A variation of an inch or two in the length of his swing would not probably be perceptible even to a practised oarsman, nor could he regulate the extent of his stroke within a smaller limit of variation. The movement is so lacking in precision that a variation of one or two inches does not vitiate or perceptibly modify it. But the finger of the violinist must be placed with the greatest accuracy on the precise spot necessary for the production of the required tone, and if it errs by so much as the tenth or the twentieth of an inch, the pitch is faulty, the action is inefficient. The movements of the draughtsman must be still more precise. Not to speak of the variation which an error of a hair's-breadth will make in the expression of a face drawn by a Leech or a Du Maurier, consider the thousands of lines in an ordinary copper or even wood engraving, note their extreme precision of direction, of thickness, and of variation of each of these elements, and it will be apparent how incomparably greater is the precision of the peripheral than of the central movements in their determination in space.

When a housewife is engaged in scrubbing a floor, the act requires and exhibits extremely little precision. Whether the portion of the floor swept over by her brush in any one movement is large or small, is at this side or that, whether the direction of her movements is in straight, or curved, or irregular lines, matters not at all to the success and efficiency of the act. And accordingly we find that in these vague movements a large share is taken by the trunk and by the relatively central muscles of the shoulder, while the digits and peripheral parts remain in more fixed positions, and contribute but little to the movement. When she has finished scrubbing her floor and begins to iron her dress, she requires to execute movements of greater exactitude. A variation of six inches or a foot to this side or that made no difference in her success in the former operation, but an error of an inch or two may materially affect the result in the latter. Whether she scrubs along or across the boards is immaterial, but to iron properly she must iron the right way of the stuff. Accordingly, we notice that while the vague movements of scrubbing are performed largely by the trunk and the trunk-limb muscles, in ironing, the trunk is steadfast, and the movements at elbow and wrist take a far more prominent *rôle*. If we follow the housewife to her next occupation, and watch her mending the dress she has ironed, we see movements of far greater exactitude, and we see these movements become more peripheral as they become more exact. In mending her dress she sits down—that is to say, she assumes an attitude in which the trunk has less play; and she sits still—the trunk does not move conspicuously. The shoulder movements, too, are slight and inconspicuous, but the movements at the elbow are frequent and large, and those of the wrist take the predominating *rôle.* The fingers are no longer mere tongs; they take a far more active part in the manipulation of the needle and cotton than in that of the flat-iron or of the scrubbing-brush. I have known a very efficient laundrymaid who on one hand had no fingers, but no one with this defect could be a seamstress. Now notice how far more exact are the movements of sewing than those of ironing. In the latter the material is arranged upon the ironing board with but a distant approximation to exactitude, and the limits of harmless variation are from half an inch to an inch. But in sewing, the material must be held at just the right place in just the right position, and in the movements of the needle an error of an eighth of an inch may make a serious difference. Let us carry our observations a stage further and watch the threading of the needle. The utmost exactitude is required for this operation, and what are the muscles concerned in it? The trunk movements are completely out of it; so are the movements of the shoulder and elbow. Even the wrists are kept as steady—as moveless—as possible by being rested against one another. The whole of the efficient movements of this extremely precise act are movements of the extreme periphery—of the digits.

The same truth may be shown in another way. If we wish to draw a line in extremely rough approximation to any given direction, as, for instance, in tracing a diagram on the ground with a stick, we carry out the action by central movements. We hold the stick in the hand, it is true, but this is only a subsidiary movement. The actual tracing of the line is carried out by movements at the shoulder—by a movement far more central in position. If the diagram is larger, and the outlines less precise, we stoop and reach first in this direction, and then in that—we employ for this vaguer purpose movements still more central. And for a still larger diagram we have to walk from place to place, relegating not the hands only, but the arms, to the subordinate position of mere tongs, and carrying out the main purpose—tracing the direction of the lines—by movements of legs and trunk, by movements that are almost wholly "central." If, however, we are drawing a largish diagram on a sheet of paper—a diagram whose outlines are necessarily traced with more precision than that drawn on the ground—we move the legs and trunk not at all, and the shoulder but little. The chief movement now is at the elbow and wrist, the digits still acting mainly as a holder, but to some extent also taking a part in the movements. As the movement becomes more precise—as the diagram drawn becomes smaller, and the lines have to be more accurately traced—the forearm is rested on the table, the elbow ceases to take any prominent part in the movement, the wrist-movements sink into subordinate importance, and the act as it becomes more and more accurate and precise is carried out more and more by the movements of the digits. In other words, while in vague and inexact acts the central movements take the prominent part, and the peripheral movements play only a subordinate *rôle*; as the act becomes more precise, peripheral movements take a larger and more leading share in its production, and the movements here called central sink into a position of subordination.

What is true of increasing precision of movements in space is true of increasing precision of movements in time. The movements that we call central are characterised by want of exactitude, while as movements become more definite in the times of their occurrence, and the lengths of their duration, the regions that take part in them shift from more central to more peripheral positions. When a sportsman starts on his day's work, the time of his arrival at the preserves may be agreed upon, but a difference of five or ten minutes one way or the other makes no material difference in the efficiency of the act; and the movements which make up the act thus vaguely defined in time are the movements of walking—movements of trunk and legs, "central" movements. When a bird rises, and he brings his gun to bear upon it, the movement, to be efficient, must be much more definitely limited in time. It must be begun and brought to completion within the brief period, amounting to but a very few seconds, that intervenes between the rising of the bird and its passing out of range. And this movement is a movement of the arms — a movement of much more peripheral character. Finally, when he pulls the trigger— a movement whose efficiency depends on its performance at an exact instant of time—he uses his digits, which are at the extreme periphery. The movements of the oarsman are indeed approximately regular, but however irregular or indefinitely limited in time they may be, the boat still progresses—the efficiency of the act is not materially impaired. But if the steersman, in following the windings of the river, pulls his lines too soon or too late, he drives the boat into the bank on one side or on the other. And the movements of the oarsman are largely movements of back and legs—central—while the movements of the steersman are of the arms and hands, relatively peripheral. Generally, if we compare acts such as those of the oarsman, the sawyer, the navvy and the blacksmith, whose component movements are but indefinitely limited in time, with those of the pianist and the violinist, whose component movements are characterised by the utmost exactitude in time, both of occurrence and duration, we find that the movements of the former are central, and those of the latter peripheral.

Number and Variety

In nothing is the difference between central movements and peripheral movements more conspicuously displayed than in the fewness and sameness of the former, and the countless number and immense variety of the latter. The movements of the trunk are limited to leanings in various directions and to a small amount of rotation; they are but few, and they are but of two kinds. Movements of the neck are freer; they admit of arrest at more numerous and more widely different intermediate positions, and are therefore more varied. Movements of the jaws are few and same. Movements of the legs, although more numerous and a good deal more varied, have still but little variety when compared with those of the arms. When we consider the arm-movements, we find an immense increase both in number and in variety. We find that the area over which the hand can be moved is almost as large as that of a sphere whose centre is the shoulder, and whose radius the length of the arm; and we find that the hand can reach three-fourths of the points between the shoulder and the area thus marked out—a number and variety of movements that has no parallel in any part of the body hitherto considered. Now take the hand, and remark the difference between the movements of the dancer and those of the musician who is playing the waltz. Observe how the feet of the dancer go monotonously through repetitions of the same succession of movements, amounting to half a dozen in all, and how little different these movements are from one another. Now observe the violinist, and notice how numerous are the positions that his hand takes upon the neck of his instrument, how much more numerous the positions of his fingers on the strings, and how widely different these positions are severally from one another, and from the positions of the other hand that wields the bow.

With each step that we take towards the periphery, the number of movements that can be executed and the amount of difference between these movements increases, until at length, when the periphery is reached, the number and variety of movements becomes enormous. Consider the number of positions in which the hands are placed during the execution of a complicated piece of music on the piano; consider the number of different positions occupied by the fingers, and that when the fingers occupy the same relative positions at different times, how many different positions the hands may occupy upon the keyboard, and the term enormous will not appear too emphatic to apply to the number and variety of movements gone through.

Again take the movements of speech, and mark how those of them which are carried out by the most central muscles are few and same, those of the periphery are numerous and varied. Considered as movement speech consists of two parts—phonation and articulation. Phonation may exist without articulation, as in humming; articulation may exist without phonation, as in whispering. In ordinary speech, which alone we are now considering, phonation is but little varied. If we hear a person speaking through a partition, such that the sound of the voice reaches us while the words are indistinguishable, we are struck by the monotony of the utterance. The sound varies but little in loudness, and there is a regular rise and fall of pitch. In other words, the movements are few and same; and these are movements of the chest and larynx—movements of central muscles. Compare these with the movements of articulation—with the number of vowel-sounds made by variations in the shape of the mouth; with the number of consonant-sounds made by variations in movements of lips, tongue and palate, and with the multitude of combinations of vowel and consonant sounds made by the combinations of these movements, and we see what a vastly greater variety there is in the more peripheral articulatory movements than in the more central movements of phonation.

If we consider the quarter of a million words of which the English language is composed, each demanding its special and appropriate set of movements, each recognisably different from all the rest; if we consider that the same individual may be able to utter all these and many thousands of words of other languages, and if we compare these movements of peripheral parts with the few movements of the back and legs, again the term enormous will be appropriate to apply to the difference.

If we look at the matter in a more comprehensive way, and compare the few and same operations in which the trunk and legs take the chief part—movements mainly of locomotion in its different forms; if we add together the movements of walking, of riding, of swimming, of rowing, nay, of bicycling, and of the various feats of gymnastics, in which these parts mainly are concerned, how paltry is their sum in comparison with the almost infinite number of handicrafts, how small their variety when compared with such handicrafts as writing, watch-making, or playing on the piano! Or compare the few and same movements of which the jaws are capable with the infinite multitude of points at infinitely numerous distances to which the movements of the eyes can be adjusted.

However the comparison is made, we still find that the more peripheral a part is in the scale laid down in p. 81, the greater is the *number* of *different* movements of which it is capable, and the *wider* is the difference between its several movements.

Generality and Speciality

If we carefully notice the movements of any peripheral part, we shall see that they presuppose movements of the adjacent less peripheral parts, or the more central portions of the physiological series which it terminates. Writing is performed by movements of the digits—of the extreme periphery of a physiological series; but these movements of the digits would be quite useless unless the hand were first placed in a certain position with the palm towards the surface written on. They would be useless unless the hand were duly carried across the paper and from top to bottom of the page. These movements of the hand could not be properly carried out unless the upper arm afforded firm points of attachment for the muscles of the forearm to pull on, and the upper arm is fixed by the great trunk-limb muscles. What is true of writing is true of every other digital movement, and it is evident therefore that no movement of the digits can be of any service or efficiency unless it is preceded and accompanied by movements of the more central parts of the physiological series to which it belongs.

Again, in ordinary utterance, the most conspicuous movements are those of the tongue and lips—of the most peripheral parts. But movements of these parts presuppose those movements of the jaws which at once allow them free play and afford to the muscles firm points of attachment at appropriate distances. These movements of the jaws could not be made unless the head were maintained in an appropriate position by the muscles of the neck and of the trunk. In other words, movements at the periphery cannot be efficiently executed without previous movements of the more central portions of the physiological series.

We have next to notice that one movement of the more central part suffices for many movements of the more peripheral part. In one attitude of the hand countless movements of the fingers can be performed, and in one attitude of the arm countless movements of the hand. While the hand rests in one position any word may be written, each word requiring a different combination of movements; and while the arm rests on the table the hand may be employed in writing, drawing, sorting, card-playing, glass-blowing, dissecting and scores of other manipulations belonging to dozens of different handicrafts. It is for this reason that we say that the movements of the hand are more general than those of the digits, and more special than those of the arm. A movement of the arm brings it into a position which is appropriate to many movements of the hand. The arm-movement is therefore *generally* appropriate to all these more *special* movements of the hand. A movement of the hand brings it into a position which subserves many movements of the digits. The hand-movement is therefore generally appropriate to all these special movements of the digits.

In ordinary utterance, the pitch of the voice alters but little. During a long conversation the general tone in which the voice is pitched undergoes but little variation; but the vowel-sounds are constantly varying; and the consonants vary still more often. In other words, a single position of the relatively central larynx suffices for many of the relatively peripheral movements of the mouth which regulate the vowel-sounds; and for very many of the extremely peripheral movements which form the consonants.

It is obvious that in the sense here used, the great trunk muscles which I have called "central" are the most general of all, for no movement of any part of the body whatever can take place, which does not presuppose and prenecessitate movement of these great muscular sheets. Whenever strenuous exertion is made, of whatever kind and of whatever part of the body, the first preliminary is to draw a deep breath. Even when exertion is not strenuous, it is obvious that no limb can act to advantage unless its central end is steadied —unless the trunk-limb muscles that move it have their central attachments firmly fixed to withstand the pull upon them; and they can be fixed only by the action of the great trunk muscles. For all efficient movement of the limbs therefore, previous action of the great trunk muscles is necessary. When it is not a case of movement of a limb, but only of the extremity of a limb—of the hand or digits, for instance—it has already been shown how necessary for efficient action it is that the whole limb should be steadied; and this steadying of the limb cannot exist unless the trunk offers a firm support and a firm basis of attachment for the trunk-limb muscles; which again necessitates action of the trunk muscles. If we leave the limbs and attend to the head, we shall see at once that no utterance is efficient if the head is allowed to loll down upon the breast, and if the head is maintained erect it is maintained by the great trunk muscles. What is true of utterance is true of vision. We cannot see plainly, we cannot estimate distances and sizes, with the head drooping forwards or on one side. It must be held erect. The visual as well as the articulating movements presuppose movements of the trunk.

Hence it appears that all more central movements form what may in microscopical terms be called a *coarse adjustment* for the movements of the parts more peripherally situated. If I want to write a letter, the first act is to walk to the writing-table—a locomotive movement of very central character; a movement which is very general, insomuch as the walk across the room might serve a hundred purposes besides that of writing; a very monotonous movement, consisting of the repetition of the same alternate movement of the legs, back, etc.; a continuous movement, which cannot be interrupted without impairing its efficiency; and a movement which may be regarded as a coarse adjustment towards the object in view. To reach down the paper and take up the pen I employ mainly movements of the arms—movements that are more peripheral, that are more varied, more interrupted, and more specially adapted to the purpose in view. When I actually begin to write, the movements are mainly of the digits—are still more peripheral, still more varied, still more interrupted, still more specially adapted to the purpose in view—constitute a still finer adjustment.

Without multiplying illustrations, the meaning attached to the terms Generality and Speciality as applied to movements will, I think, be apparent. By a general movement is meant one which is presupposed by and enters as a component part into many other movements. By a special movement is meant one which serves a special purpose, and that only. Estimated according to this standard, the most general movements are those which are most central, and movements diminish in generality and increase in speciality as we proceed from the centre of the body to the periphery.

Simplicity and Complexity

From what has been already said, it will be evident that those acts which are mainly composed of central movements are relatively simple, while those in which the peripheral movements take the leading *rôle* are relatively complex; and that as we leave the centre and approach the periphery, the acts that come under our consideration increase in complexity. If by complexity we mean the number of different *parts* that share in the performance of the act, it is manifest that acts in which the peripheral movements take the leading *rôle* must be more complex than those which are mainly carried out by central movements; for central movements may occur alone, while peripheral movements, as we have just seen, presuppose and prenecessitate subsidiary adjusting movements of all parts central to them. If, on the other hand, we mean by complexity the number of different *directions* taken by the parts concerned in the act, then it is equally evident that peripherally-led acts are more complex than centrally-led acts. The directions in which the legs are moved in walking are but two—forward and backward; and if we add the direction of the body movement, we have but to add a slight up-and-down movement. The directions of the movements in rowing are similar—mainly backward and forward, with a slight up-and-down swing. The sawyer moves only up and down, with a slow progression along the beam on which he stands. But if we notice a shoemaker shaping a piece of leather, we see his hand turn and twist about in the most various directions, according to the shape of his pattern. If we watch a moulder at work, we see him laying stroke upon stroke, scraping off a bit of material here, laying on a bit there, sharpening this corner, rounding that curve, by a multitude of movements, no two of which are alike in direction. In writing this page, in addition to the double direction of my hand from side to side of the paper and from top to bottom, the directions in which the digits move are as various as movements in one plane can be.

The conclusions at which we arrive from the foregoing considerations are that the movements here called central are continuous in duration, vague in limitation, few in number, same in character, and form a general, approximate or coarse adjustment; that progress towards the periphery brings us to movements that are more intermittent in duration, more precisely defined, more numerous, more diversified, and more specially adjusted to particular ends; and that when at the eyes, the articulatory apparatus and the digits, we reach the extreme periphery, all these characters reach their highest degree of development.

CHAPTER V

CO-ORDINATION OF MOVEMENTS

NOT yet have we exhausted all the differences between central and peripheral movements. The most important of all has yet to be considered.

It has been shown that no movement can be successful or efficient unless all the muscular actions that contribute to it are co-ordinated in simultaneity—unless they are simultaneous in beginning, in duration, and in cessation. What is true of muscular actions is true of many movements also. Among the movements that are performed by the human organism there are many that never occur alone, but are invariably associated with other movements with which they are in all respects simultaneous. There is another and far larger class of movements which owe all their importance, all their efficiency, and all their success, to the fact that they form part of a series—that they are interposed between previous movements and subsequent movements—that they carry further the work done by preceding movements and prepare the way for movements that are to follow. Thus we have one more great division of movements into two most important classes: those that are combined with other movements with which they are simultaneous; and those that are combined with other movements in sequence; and it is extremely significant that this division coincides with the other divisions already considered, those movements which are combined (co-ordinated) in simultaneity being mainly central, while those which are co-ordinated in succession are predominantly peripheral.

In the process of ordinary respiration, the parts concerned are simultaneous in their movements. As inspiration commences, the diaphragm, the muscles of the abdominal walls, those that raise the ribs, and those that open the glottis, start simultaneously into action. As expiration begins, the whole of the actions are simultaneously reversed. Looking at the raising of the ribs as a different movement from the depression of the diaphragm, and at the opening of the glottis as a movement separate from both of these, we may disregard the numerous muscular actions which severally contribute to these separate movements, and look upon the movements themselves as co-ordinated in simultaneity. And in this well characterised instance of the co-ordination in simultaneity of several widely different movements, the movements are all markedly central in position. Still more numerous are the movements that are thus co-ordinated in laboured respiration. In addition to the movements already enumerated, there is, in forced inspiration, straightening of the trunk, raising of the shoulders, throwing back of the head, opening of the mouth and distension of the nostrils; and all these movements, as well as the contrary movements with which they alternate, are severally co-ordinated in strict simultaneity. Two things are to be noticed with regard to these additional movements: first, they are all relatively central movements; and second, they are less central than the movements of ordinary breathing on which they are superposed. The movements of the diaphragm, of the ribs and abdomen, not forgetting the continuous extension of the spine which renders these movements possible, are all central in the most extreme degree; but the movements of the neck, of the shoulders, and of the jaws, are one degree more peripheral. In this case therefore co-ordination in simultaneity affects first and most the more central movements, and as it extends it spreads towards the periphery, involving last and least the parts furthest from the centre. And this is true generally of all cases of co-ordination in simultaneity.

When a man stands upright, his position is maintained by the combined action of a great number of muscles, the great majority being very central in position, and all being co-ordinated in simultaneity. By the accurate adjustment to one another (co-ordination) of the pulls of these various muscles, not only is the upright position maintained, but it is so maintained that the vertical through the centre of gravity is made to pass through such a point of the supporting area that the sum of all the tensions of all the muscles employed is a minimum. Bearing in mind what was said in p. 83, that a movement in the physiological sense does not necessarily involve motion, this maintenance of the erect position may be said to be due to the co-ordination in simultaneity of the movements of the trunk and legs. If the man starts to walk, the main area of support is continually shifting from one foot to the other, and as the area of support shifts, the centre of gravity must be continually adjusted so as to be maintained vertically over it. It matters not whether this adjustment is carried out by the carriage of each foot in succession vertically under the centre of gravity while the latter is maintained in the same fore-and-aft plane, or whether the feet move in separate planes, and the centre of gravity is made to oscillate between them. In either case there is one set of movements (the forward and backward swing of the legs) which has to be performed synchronously with another set of movements (those of equilibration). The two sets of movements are co-ordinated in simultaneity, and each set is mainly central in position. If the man is walking on a narrow and uncertain foothold, his movements of equilibration become more pronounced. He throws out his arms, and we see that while the movements of the trunk are exaggerated and the arms are kept abducted at the shoulders, what movements these limbs execute are movements at the shoulders mainly. The movements at the elbows are relatively unimportant, and the hands take scarcely any share in the process. In these exaggerated gestures we can see clearly how accurately simultaneous the movements of equilibration must be with the motion of the area of support, for if at any moment the simultaneity is not observed—if he fails to keep the vertical through the centre of gravity within the area of support—down he goes. At the same time that we notice how conspicuous an example of co-ordination in simultaneity is presented by equilibration, we shall notice also that this process is carried out first and most by the most central movements—those of the trunk and legs—and that, as it spreads, it involves next the movements next in order from the centre—those of the neck and shoulders; while the extreme periphery takes little or no part in the matter. It is a curious, almost a fanciful, corroboration of this doctrine, that in laboured equilibration the jaws are usually separated, and participate in the side-to-side lurchings of body and limbs. These movements of the jaws cannot have any appreciable effect on the result, they cannot be of any service in equilibration, but they serve as an unexpected illustration of the tendency of this class of movements to involve in its spread the movements most nearly allied to the central.

Another case of co-ordination in simultaneity has already been mentioned in treating of generality of movement. In p. 94 it was shown how essential it is when a peripheral part moves, that its central end should be fixed or steadied by the action of more central muscles. It is evident that such fixation or steadying is begun simultaneously with the movement; and although such co-ordination in simultaneity is a co-ordination more of muscular actions than of movements, yet it is worth while to notice that, while every peripheral movement involves co-ordination in simultaneity of peripheral with central muscular actions, yet, since peripheral movements are far more numerous than central movements, every movement of a more central part must be absolutely much more often co-ordinated in simultaneity than any movement of a more peripheral part of the same physiological series. For each movement of the more central part serves as the basis for many movements of its periphery.

The more central a part is, the more often are its movements co-ordinated in simultaneity with parts belonging to different physiological series. The most central parts of all—the great trunk muscles, which form the starting-point from whence the several physiological series diverge—partake in and are co-ordinated in simultaneity with the movements of every series. The movements at the shoulder are co-ordinated in simultaneity with all the movements of the arm; with many movements of the trunk, as in reaching in various directions; and with some movements of the opposite leg, as in the swing of the arms in walking. The movements at the elbow are co-ordinated in simultaneity with a few movements of the opposite limb, as in winding a ball of string, tying a knot, whittling, etc., and with a very few movements of the head and mouth, as in eating. In most handicrafts the movements of the two hands are, it is true, co-ordinated in simultaneity. The nail is held with one hand while it is hammered with the other; the stick is held with one hand while it is cut with the other; the cloth is held with one hand while it is sewn with the other; the paper is held with one hand while it is written on with the other; the glass is held in one hand while it is filled from the bottle in the other; and so of countless manual operations. But how imperfect, inaccurate, and unimportant is the simultaneity in these cases in comparison with its exactness and urgency in the acts of equilibration! The material is held in the one hand *while* the instrument is wielded with the other; but while the latter goes through a succession of movements that may be very numerous and very varied, no corresponding variation occurs in the movements of the former. There is a vague and general accordance in the time of movements of the two hands, an accordance which extends as far as this,—that the movements of the one endure, on the whole, about as long as the movements of the other; but that exquisite instant adaptation of one movement to another, which we see in the absolute simultaneousness of the widening and narrowing of the glottis with the falling and rising of the diaphragm, has no existence in the co-ordination of the one hand with the other in simultaneity. In those cases in which the movements of the two hands are more definitely simultaneous in their beginning and ending,—in such acts as clapping the hands, wielding a cricket-bat or pulling a rope,—the part taken by the hands is a subordinate one, the chief *rôle* being taken by movements of a more central character—by those of the arms, of the shoulders, and even of the trunk.

What is true of the co-ordination in simultaneity of one hand with the other is true also of the co-ordination in simultaneity of the movements of the hands with those of the eyes. The simultaneity of the eye-movements with those of the hand is approximate only, and is far less precise than that of the central movements with one another. Moreover, the eye-movements which are co-ordinated in simultaneity with the hand-movements are the movements of accommodation—the convergent movements which give us clear vision of what our hands are doing; and these movements are classified as relatively central—as ranking next to the movements of the jaws,—that is to say, in a position but little removed from the centre. This apparent exception is really therefore a confirmation of the rule ascribing to central movements the greater share in co-ordinations in simultaneity.

It is not denied that the hands may very often be *in motion at the same time* as other parts of the body; but this is a very different thing from being co-ordinated with them in simultaneity. Co-ordination, as already explained, means combination—combination in due proportion—and movements which occur simultaneously are not co-ordinated in simultaneity unless they are combined *for a common end*. That lad who is passing my window is carving a stick and whistling as he goes. He is executing simultaneously the three acts of walking, carving and whistling; but these three sets of movements are not co-ordinated in simultaneity, for not only is the rhythm of each different from that of the other two, but each subserves a totally different end, and can be carried on in complete independence of the others. He could walk and whistle just as well with his hands in his pockets, and he could carve his stick just as well sitting down and silent. The three sets of movements are simultaneous, but are not co-ordinated in simultaneity. Not so the movements of the legs and trunk, that combine to effect the common aim of walking; nor the movements of the hands, that combine to effect the common aim of carving; nor the movements of mouth and chest, that combine to effect the common aim of whistling. These must severally act simultaneously. Let one leg cease to perform its part, and walking is at an end. Let one hand cease to perform its part, and carving is impossible. Let the mouth break into a smile, and whistling ceases perforce.

From the foregoing considerations it appears that while movements of all parts of the body are liable to be co-ordinated in simultaneity with other parts, yet the most perfect, the most frequent, the most important, and the most conspicuous examples of this form of co-ordination involve the movements that have been characterised as central; and when, from any reason, additional movements become involved, the co-ordination spreads first to those parts immediately adjacent to the centre, and then to those more and more remote; so that in the most perfect examples of this form of co-ordination the central movements are involved first and most, and the peripheral movements last and least. On the other hand, when the peripheral parts are co-ordinated in simultaneity, we find that if the co-ordination is precise, the share taken by the peripheral movement in the act is a subordinate one; while if the peripheral movement is the chief movement in the act, the co-ordination in simultaneity is vague, inexact and approximate. As we progress from the centre to the periphery, we meet with parts that are less often co-ordinated in simultaneity with other parts; that are so co-ordinated with fewer different parts; that when accurately so co-ordinated take a subordinate share in the act; and that when taking a leading *rôle* in the act are but approximately simultaneous in their co-ordination.

In co-ordination in succession these rules are reversed.

In this form of co-ordination the peripheral parts take the leading *rôle*, and the central parts sink into subordination. It is not said that the central parts never enter into sequential movements. Unquestionably they do so, but not only are they co-ordinated in succession far less frequently than the peripheral parts, not only do they play a subsidiary part in such sequences as they enter into, but the sequences in which they take the predominating *rôle* are shorter, are less accurately determined, are less compound and less complex, than the sequences which most concern the most peripheral muscles. Co-ordination in simultaneity affects the central movements first and most, spreads towards the periphery, and affects the most peripheral movements last and least. Co-ordination in succession involves the most peripheral movements most often, and in the most prolonged and complex sequences; and when, as often happens, the succession of movements begins centrally and spreads to the periphery, it is the most peripheral movements to which all the others are subservient, and act as aids and adjustments. Such are the observed phenomena of co-ordination of movements.

When I stretch out my arm to pick up a book, the movement will be useless unless it is followed by the movement of grasping; and when I have got the book in my hand, the movements, so far successful, will be no use unless they are followed by the further movement of placing the book where I want it. The entire act will not be effectual, or successful unless the appropriate movements occur at proper times and in proper order—unless they are duly combined in sequence—unless they are co-ordinated in succession. The movement of one leg in walking is no use, unless it is followed at the proper time by the movement of the other leg. If the second movement takes place too soon, or too late, or not at all, the act as a whole is impaired in efficiency or is a failure. For the act to be successful, the movements must follow one another in proper order and at proper times; they must be co-ordinated with respect to their succession. Suppose that the movement of grasping occurs before the arm is stretched out instead of after, the book will not be picked up. The act will be a failure, and it will fail because its component movements did not occur in their right order, because the sequence in which they should have occurred was altered,—because the time of grasping was not duly proportioned to the time of reaching,—because the movements were not co-ordinated with respect to their succession. Similarly, if, in walking, the movement of advancing and planting one foot is followed by another step of the same foot, it is evident that the walk is not duly performed. The act of walking is a failure; and it fails because the movements observe a wrong order, because the succession of movements is altered—is not duly proportioned—is inco-ordinated.

What is true of two successive movements, such as reaching and grasping, and of two movements repeated in alternation, such as those of the legs in walking, is true also of every succession of movements, however long and complicated, which enter into the composition of a single act. If I want to fetch a book from the bookcase at the end of the room, I must rise to my feet, walk across the room, open the bookcase, raise my arm, take down the book, and walk back again. If any one of these movements occupies a wrong position in the sequence, the act as a whole is a failure. It is no use raising my arm to take the book before I have opened the bookcase, nor is it any use going through the form of opening the bookcase before I have reached it, nor will the act be successful if I defer the movement of grasping until I have got back to my seat. In order to produce a complete and successful act, every movement must come in its right place in the series—must occur in orderly sequence—must be co-ordinated in succession.

When treating of co-ordination of movements in simultaneity, it was pointed out that movements may occur together without being so co-ordinated; and similarly it does not follow because movements occur successively that therefore they are co-ordinated in succession. The movement of dipping the pen in the ink precedes the movement of writing, and the two movements are co-ordinated in succession, for if they were performed in different order, the act would be a failure. The movements of lighting the pipe precede the movements of writing the letter, but are not co-ordinated in sequence with them; for it makes no difference to the efficiency of the act whether the pipe is lit before or after the letter is written. Movements are not co-ordinated in succession unless they are combined in a certain order to attain a common end.

Sequences of movements may be simple, or compound, or complex in various degrees. The simplest sequence is simple alternation. Such is the movement of the jaws in eating. The movement of opening the jaws is followed by the movement of closing, which again is followed by opening, and so on in alternate repetition. The next simplest sequence is compound alternation, in which a movement of one part is followed by a movement of another part, which again is followed by a movement of the first part, and so on in alternate repetition. Such is the movement of the legs in walking. When the movement of one part is followed by the movement of a second, and this by the movement of a third, and so on, the sequence is compound. Such a sequence occurs when a morsel of food is reached for, grasped, carried to the mouth, bitten, masticated and swallowed. Lastly, a complex succession occurs when a movement is followed by a different movement of the same part, this again by a third movement of the same part, and so on in succession. Such sequences occur in the movements of the hands in every handicraft, and in those of the mouth in speaking. The greater the number of parts of the body whose movements follow one another in the execution of any act, the more compound is the sequence. The greater the number of different movements performed by any one part in the execution of an act, the more complex is the sequence.

It is obvious that the movements of the trunk cannot be co-ordinated in a very complex succession. Being capable of but very few different movements, if all the movements of which it is capable follow one another, the sequence is yet not very complex; and ordinarily the sequence of central movements is limited to simple alternation. It is equally obvious that the mouth and the digits, which are capable of an immense number of different movements, are also capable of executing many of these movements in combined succession—are capable of an immensely greater complexity of sequence in movement than are the central muscles. If we watch the acts of a carpenter, or a worker at any other form of handicraft, we shall see that when they are composed of repetitions of the same movement, or of movements in simple alternation, the trunk, the legs, and the arms are the parts chiefly concerned; but when the act is composed of a long succession of different movements, these movements are peripheral in character. The acts of sawing, of planing, of heaving, of pounding with a rammer, of delving with a mattock, of hewing with an axe, are composed of simple alternations of movements; and these movements are mainly movements of the trunk, legs, and arms, the hands taking only the subordinate part of holding the implement. But watch the same man taking the blade out of his plane, or setting his saw, or splicing his rope, or wedging on more securely the blade of his mattock or his axe, and what do we see? We see acts made up of many different movements, following one another in a long succession; and we see that in these movements the trunk and legs are still, or nearly so. They take little or no part in the act. But the hands, which in the previous act executed no intrinsic movement, are now all activity. They are turned and twisted this way and that; they grasp now this wedge and now that hammer, and hold it now with the tips of the fingers and now with the whole hand. They assume many attitudes, and occupy with almost every attitude a new position in space.

If we notice the several sequences gone through by different parts during the same act, we shall see that the same law holds good. As I write this page the movements of the digits by which the letters and words are formed are involved in a succession of such extreme complexity that the sequence which forms one word is different from that which forms every other word; the sequence which forms each sentence is different from that which forms every other sentence; and the sequence which forms any given word is repeated seldom in comparison with the sequences that form other words. In other terms, the number of different movements is very great, and the same movement does not recur with regularity—the rhythm as well as the sequence is complex. Subsidiary to the extremely peripheral movement of the digits in forming the letters, is the movement of the hand across the page; and this more central movement is a movement of simple alternation, compounded only with the movement from top to bottom of the page,—it is a simple succession with a brief and simple rhythm.

The same law holds good whichever physiological series we examine. In vocal utterance there are three sets of movements: those of breathing, those of phonation, and those of articulation. Breathing is effected mainly by the most central of all muscles; and its movements occur in simple and regular alternation—in simplest succession and in brief and simple rhythm. Voice is produced mainly by movements of the larynx—movements that are midway between the central movements of breathing and the peripheral movements of articulation; and the sequence of these movements is intermediate in complexity between those of breathing and those of articulation. If we hear a person speaking at such a distance or through such a position that we hear the modulation of the voice without distinguishing the words, we notice a rise and fall in pitch, which, though not nearly so regular as the movements of breathing, is yet approximately regular; the range of difference between the sounds being not very wide, and the same pitch being approached at intervals that are not very unequal and not very long. In other words, the number of different movements is greater than in breathing; the differences between the movements are wider, and the rhythm of the recurrence of the same movement is both longer and less regular. The sequence is in all respects more complex. Now advance to the extreme periphery and take the movements of articulation. Each spoken word, like each written word, requires for its formation several movements succeeding one another in definite order at definite intervals; and each sentence is a long sequence made up of many such shorter sequences arranged in definite order. The number of different movements of the articulatory apparatus that goes to make up even a short speech is therefore enormous; and these movements and sequences of movement recur rarely and at intervals that are extremely irregular. Compared with the sequence of sounds that give body to them, the articulatory movements that follow one another in the formation of a word or a sentence are far more numerous, far more varied, and occur in rhythm of far greater complexity. The sequences are in all respects more complex. They are also more compound.

So far as complex succession is concerned, it is evident that this form of co-ordination reaches a far higher development in the movements of the periphery than in those at the centre; and the expectation which was raised by a knowledge of the few and same movements of the latter in comparison with the various and multitudinous movements of the former is amply confirmed by observation.

Compound sequences, or co-ordinated successions of movements of different parts of the body, are of two main groups, each group containing two orders. The first group consists of those sequences which follow the order of the physiological series, beginning at the centre and spreading to the periphery, or *vice versâ*. The second group consists of those sequences in which a movement of a physiological series is followed by a movement of a different physiological series, or a movement of a peripheral part is followed by one of a different but equally peripheral part. When an object is moved from one place to another, the movement of reaching is followed by a movement of grasping, which is followed by a movement of reaching, which again is followed by a movement of leaning. The movements follow one another in the order of the physiological series and spread from the periphery to the centre. The sequence is centripetal. In pulling an oar, the back and legs are first extended, then the arms are bent, and finally the oar is feathered by a movement of the wrists. In this case a central movement is followed by an intermediate movement, which again is followed by a relatively peripheral movement. The movements follow the course of the physiological series from the centre to the periphery. The sequence is centrifugal. In a drop-kick at football the act consists of a movement of the arms followed by a movement of the legs. The sequence in this case is from one physiological series to another. Lastly, in the successive movements of the several digits of a musician, we have an instance of the sequence of movement from one peripheral part to another equally peripheral. The centripetal and centrifugal sequences we may group together under the title of "radial" sequences, while the succession from series to series may be grouped with the succession of periphery to periphery under the title of "lateral" sequences. We shall see that the sequences in each group have other affinities besides that of similarity.

The two forms of radial sequence — centrifugal and centripetal — usually occur in close association, often in alternation, and not unfrequently are combined in the same act. The most important and most frequent act made up of radial sequences is that of walking. The order of movements of the leg in walking, beginning at the rearward position, is raising of toe, bending of knee, swinging at hip, straightening of knee, extension of foot. In addition to the alternation of the movements of the two legs there is an alternation in the movements of each leg of a centrifugal and a centripetal sequence. When I lean forward, reach out my arm, and grasp this book which is nearly beyond my reach, the sequence of movement is centrifugal. As I grasp it, withdraw my arm, and recover my position, the sequence is centripetal. When I place it on this other book and relinquish the grasp the sequence, still radial, is again reversed in direction. When I fetch an object from a distance, the central movement of walking is followed by the intermediate movement of the arm, which is followed by the peripheral movement of grasping; the sequence is so far centrifugal. But then follows the reverse order; the hand with the object in it is lifted into a certain position by the movement of the arm, and is thus maintained while the central movement of walking is performed. Without adducing further illustrations the reader will be able to perceive from what has been said, and from the many examples that will readily occur to him, that all radial sequences, both centrifugal and centripetal, are alike in the following respects. First all the acts into whose composition they enter are *locomotor* acts, by which is meant acts which have for their aim the translation of the body as a whole with respect to its surroundings, or the translation of individual objects to different positions with respect to the body—the placing of objects here or there, or the movement of the body hither or thither. Second, all radial sequences, if they are accompanied by movements of the eyes, are accompanied by movements of convergence or divergence — by movements of accommodation. That this is likely to be the case will appear, when we remember that all acts composed of such sequences aim at moving the body to or from something, or at moving something to or from the body. When it is a question of moving objects without altering their distance from the body, the sequence of movement is not radial. Thirdly, while the movements which compose a radial sequence must be accurately co-ordinated in space, there is not the same necessity for their accurate co-ordination in time. This last point is very important, and requires a little explanation. When I lean and reach to grasp an object, say two and a half feet off, the distance reached must be accurately proportioned to—must be precisely co-ordinated with—the distance leant. If the leaning extends to six inches, the reach must be two feet, and for every inch more or less of leaning there must be an inch less or more of reach; unless the two movements are co-ordinated in space the act is a failure. But there is no necessity for *precise* co-ordination in time. So long as the movements occur in the appropriate *order*, the moment of commencement or the precise duration of each may vary within wide limits without vitiating the success of the act.

Finally, it should be noticed that the co-ordinations in radial sequence as a whole have a strong affinity to co-ordinations in simultaneity. Not only do the times of the several movements composing a radial sequence overlap one another, so that one begins before another is finished, and all may perhaps actually at some period of the act be in operation together, but they concern very largely the central movements which, as we have seen, are most concerned in simultaneous co-ordination. In lateral sequences on the other hand the movements are more strictly successive in character, the preceding one being virtually over before the succeeding one begins; and they chiefly concern the peripheral movements, which are mostly concerned in complex succession.

In lateral sequences, however, it is precisely the accurate determination of the precise moment at which one movement shall follow another, that is the important element in the succession. The accurate determination of the space traversed is often important, but it is the time-element that preponderates. In the example already adduced of the drop-kick at football this is sufficiently apparent. The kick must be made at a certain precise interval after the hands have dropped the ball, such that the foot meets the ball at precisely the right spot in its descent. If the foot is an instant too soon or too late, the act is either faulty or fails altogether. When food is conveyed to the mouth, the movement of the arm-series is taken up by movement of the mouth and jaws; and it is obviously essential that the closure of the mouth should follow accurately upon the arrival of the morsel of food, otherwise the act will fail. When an object is tossed from one hand to the other, the movement of catching must follow the movement of throwing at precisely the right interval, or the act will fail. In the lateral sequences gone through by the fingers of the musician, the accurate observance of the precise intervals of time at which they succeed one another is an element of prime importance.

To recapitulate the contents of this chapter. As muscular actions are combined together in definite ratio, or co-ordinated, to form movements, so entire movements thus constituted are co-ordinated to produce acts. The co-ordination of movements into acts is of two chief forms: co-ordination in simultaneity, and co-ordination in succession. Co-ordination in simultaneity is similar, and closely allied, to the co-ordination of muscular actions; it concerns, first and most, the most "central" movements, last and least the most peripheral. Co-ordination in succession may be either in compound succession or in complex succession. A compound sequence is the succession of a movement of one part of the body by the movement of another part. It may be a centrifugal sequence, the order of succession spreading from the central movements to those of the periphery; or it may be a centripetal sequence, the order of succession spreading from the peripheral movements to those of the centre; and in either case the sequence is termed radial. Or the succession may be from one physiological series to another—from the arm to the leg, for instance; or from one peripheral part to another equally peripheral, as from one digit to another; and both of these forms of sequence are termed lateral. While radial sequences are allied in character, and in their predominantly central position to co-ordination in simultaneity; lateral sequences are allied to the complex, and affect first and most the movements of the periphery.

CHAPTER VI

THE NERVOUS MECHANISM OF CO-ORDINATION AND INHIBITION

SUCH being the observed facts of bodily movement, it remains to discover and to infer from these observations the nature of the nervous mechanism by which these movements are brought about.

The problem presented by the co-ordination of movements in simultaneity is simple. This form of co-ordination is precisely similar to the co-ordination of muscular actions treated of in Chapter IV., from which indeed it is in its simpler forms indistinguishable, and there can be no doubt that it is effected by the same means.

It was found in dealing with the co-ordinations of muscular actions into movements, that reasoning rendered probable and experiment proved, that the simultaneous action of various muscles was due to the simultaneous discharge of a number of groups of cells aggregated together in what is termed a "centre." An impact of force on the centre sets all the component groups of cells discharging simultaneously, and then results simultaneous action of many muscles. If we imagine a number of such centres grouped into a cluster, then an impact on the cluster will produce simultaneous discharge of all the centres, and simultaneous occurrence of all the movements represented.

In the previous chapter it has been shown how close is the resemblance, or rather how little is the differentiation, between the co-ordination of movements in simultaneity, and the co-ordination of muscular actions into movements, and it may justly be argued from this resemblance that the mechanisms on which the two phenomena depend are also alike.

But are we not making rather a large assumption when we suppose an impact to occur in several centres simultaneously? A nerve-centre occupies a certain space. The centres which are most often co-ordinated in simultaneity are those which represent the larger muscles (Chapter V.), and are therefore themselves of large size (Chapter III.). So that to discharge several such centres simultaneously, the wave of nerve-force must be of such great magnitude that it would cause a general disturbance. Undoubtedly this would be true if we suppose the centres to be set in action by a generally diffused wave. But this is not the supposition. It is evident that there would be an enormous saving of physiological labour if we suppose that each of the centres, whose simultaneous discharge is required, were placed in relation by wide nerve-paths with one superior centre common to all. Discharge of this superior centre will then cause simultaneous discharge of all the subordinate centres, and the desired movements will take place simultaneously. It will be remembered that something more than simultaneity is required. The force of each movement must bear a due proportion to the force of the others. Now the force of the movement is determined by the amount of the nervous discharge (Chapter III.), and the amount of discharge from a centre is determined, *cæteris paribus*, by the amount of the initiating impact. So that the force of the movements will be in proper ratio to one another if the initiating impacts on the several representing centres are in proper ratio. Here is a further similarity between the centre which co-ordinates muscular actions and the centre which co-ordinates movements. Muscular actions are co-ordinated as to their forces by the issue to them of nervous discharges in due proportion from a single centre. Movements are co-ordinated as to their forces by the issue to their representing centres of nervous discharges in due proportion from a single centre. Other things being equal, the amount of discharge delivered by a nerve-channel is proportionate to the calibre of the channel. Hence it appears that the simultaneous occurrence of any number of movements in a certain proportion may be determined by the discharge of a single centre which is connected with the centres representing the movements, by channels having the desired proportion.

It is evident that a still more comprehensive co-ordination in simultaneity could be effected by the grouping of several such superior centres under one of still higher rank.

Hence it appears that the portion of the nervous system that effects co-ordinations in simultaneity is disposed in an arrangement resembling the roots of a tree. The smallest radicles are represented by the terminations of the nerve-fibres in the muscles. The next larger rootlets are represented by the nerves as they issue from the muscular sheaths. The aggregation continues until the centres are reached, and here a further combination unites the muscles into groups, the groups into clusters at once larger and fewer, and the clusters into congeries still larger and less numerous. Thus the lowest centres of this series represent but a restricted portion of the organism, while the higher the centre is in the series, the larger and larger is the proportion of the whole organism that it represents. In the highest centres of all the entire organism is doubtless represented, but represented in a different way in each of them,—that is to say, in one centre one part of the body will be preponderately represented, and in another, another.

There still remains a question to be dealt with in connection with the centres effecting co-ordination in simultaneity, viz. in what part of the organism are these centres situated? To this question we shall return, but for the present we will leave the question of co-ordinations in simultaneity, and consider what arrangement will subserve the co-ordination of movements in succession.

Since every separate movement depends on the action of a separate centre, a succession of movements must depend on the successive discharge in proper order and at proper intervals of the nerve-centres representing the movements. It has already been shown that the influence which starts the action of each centre, and which therefore determines the succession, is due ultimately in all cases to impressions made on the body by the world outside it. But only in the case of reflex action does this influence come directly from the outside world. In all other cases it reaches the centres to be set in motion through other centres more or less numerous and remote. It is the arrangement of these centres that we have now to study.

Sequences of movement were divided in Chapter V. into compound and complex; and the complex sequences, those in which a movement of one part is followed by a movement of another part, were further divided into the radial sequences and the lateral sequences.

Let us take a radial sequence,—let us take, for instance, such a series of movements as those of prehension,—that is to say, grasping of thumb and finger, rotation of wrist, flexion of elbow, adduction at shoulder, and let us inquire whether we have any evidence of the relative position of the centres which actuate this group of movements. We have evidence of three kinds—evidence from three distinct sources—which, taken together, leaves no reasonable doubt as to the method in which these centres are arranged.

First, there is the evidence of Jacksonian epilepsy. The spasm in Jacksonian epilepsy is always in *radial sequence.* It begins in thumb and finger and spreads to the wrist, up the arm and to the shoulder, and so onwards. Or it begins in the great toe and spreads up the leg. Or it begins with twitching of the corner of the mouth, or turning of the eyes, and presently spreads to the rest of the face, to tongue, jaws, neck and trunk. In every case the sequence is radial and is centripetal. Now, it is beyond dispute that in Jacksonian epilepsy the discharge begins in the cortex cerebri. Hence we may safely infer that the movements of all peripheral parts are represented in the cerebral cortex. When we remember that of all movements those of the periphery are the most precise, the most delicate, the most complex, the most elaborate, it is not surprising to find them represented in a region to which is ascribed by common consent an elevated function.

Once started, an epileptic discharge will spread, according to purely physical laws, to whatever districts are in most direct communication with its starting-point; and as the epileptic tempest in the nerve-centres spreads, so will the convulsion in the muscles increase. For every additional nerve-centre involved in the storm a new movement is added to the muscular turmoil, and from the order in which the muscles become affected by the spasm, we can infer the way in which the centres are grouped around the focus of the discharge. The reader should bear in mind at this point the difference previously pointed out between the representation in the nerve-centres of a *muscle* and the representation of a *movement*. For every *movement* a separate centre is required. But the same muscle takes part in many movements, and therefore is represented over and over again in many centres. Suppose one of these centres to discharge excessively, as in epilepsy; then there will be a single movement of undue strength. But suppose many centres, all representing movements of the same part, say of the hand, to discharge excessively. What will happen now? All the movements will tend to occur at once, and to occur in excess. From a score of different centres a score of different impulses are sent to each muscle concerned in moving the hand; and to each muscle all the impulses carry the same message. Every impulse clamours to the muscle for excessive contraction. To this urgent and multiple demand the muscle answers with all its strength. Movement in the ordinary sense cannot take place, for movement requires the combination of muscular actions in *due proportion*, and here all proportions are demanded simultaneously. The muscles are, however, the faithful slaves of the nerve-centres. They respond actively to all the messages, and the result is that the limb becomes as rigid as an iron bar. It becomes what Dr. Hughlings Jackson calls a "clotted mass" of spasm.

It is evident that from observations on the march of such a spasm we cannot hope to derive much knowledge as to the arrangement of individual centres, for individual centres mean individual movements, and no individual movements occur. But what can very safely be inferred from them is the arrangement, not of individual centres in which separate movements are represented, but of regions in which many movements of a given *part of the body* are represented.

The march of the spasm in Jacksonian epilepsy is threefold. If a fit begins in the thumb and index finger, then as the fit proceeds three things happen simultaneously. The spasm in the thumb and index finger becomes stronger; the other fingers become convulsed; and the hand, as a whole, is fixed or moved,—that is to say, movement at the wrist is superadded. Translated into the phraseology of the previous chapters, this statement becomes as follows:—The spasm commences in the extreme periphery. As the fit extends (1) the spasm in the part already affected is intensified; (2) the spasm spreads to neighbouring portions of the periphery; and (3) it attacks the part next in order towards the centre. At the next step the digits are still more affected, the movement at the wrist is increased, and movement at the elbow begins. At a further stage all these movements are intensified, and a movement at the shoulder is superadded.

We will now shift our point of view from the muscular movements to the nerve-centres, and see what is the meaning of the observations on the former when translated into terms of the latter.

The increased intensity of the spasm of finger and thumb may be accounted for in two ways. It may be due to increased intensity in the discharge from the centre originally affected; or it may be due to discharge of other centres representing other movements of the same two digits. It has already been explained how simultaneous discharge of several centres representing different movements of the same part, will produce, not any definite movement, but a fixed rigid spasm of the part represented. It follows from the general principle of evolution that all the centres representing allied movements of the same part should be aggregated together. There can be no doubt that the separate movements of the first two digits were differentiated from the movements of the remaining digits by differentiation of the centres representing the first-mentioned movements from the general centre or centres representing the last. And if all the minor or secondary centres were differentiated out of a previously existing centre, then all the secondary centres must be *grouped together*. It would obviously be a great waste of material if the different centres representing closely allied movements of thumb and finger were dotted about the cerebral cortex at wide intervals, each centre requiring, of course, its separate set of communications with the same muscles, etc. Hence, from either mode of reasoning, we may be quite sure that all the centres representing allied movements of thumb and index finger are grouped together in one small patch of the cerebral cortex. And the conclusions thus reached are corroborated by experiment. If these centres are so aggregated, then the overflow of discharge from any one of them that is discharging excessively will first impinge on other centres of the same group, and these remaining centres of the group will be the first to join in the epilepsy. Hence it appears that the increase of the spasm in the parts first attacked may be, and probably is, due to both the causes suggested,—that is to say, increased intensity of discharge from the centre first disturbed, and added discharge from centres representing other movements of the same parts.

What is true of the differentiation of the movements of the thumb and finger from those of the other digits will evidently be true also of the differentiation of the movements of all the digits from those of the hand as a whole, and by a parity of reasoning the centres representing the allied movements of the remaining digits should be in close approximation to each other and to the centres representing the movements of thumb and finger. The observed facts of Jacksonian epilepsy shows that they are so approximated, since simultaneous with the increase of the spasm in the digits first affected is its spread to the remaining digits. Hence we conclude that all the centres representing allied movements of the digits are clustered together at a single spot in the cortex cerebri.

But there is a third factor in the spread of the spasm. Simultaneous with the increase of the spasm in the first affected digits, and with the invasion of the remaining digits, a movement of the wrist takes place in consequence of spasmodic action of the muscles of the forearm. What is the position of the centre or centres representing this movement? Obviously such centres must be in very close approximation to those already localised, or the spasm of the muscles that they represent could not be simultaneous with that of the inner digits. Are we to suppose then that these centres are situated in an adjacent area of the cortex? I think not; and my reason for so thinking, although not originally derived from them, is most clearly demonstrated from the facts of experiment. When the electrodes are placed on the proper convolution of a monkey's brain, and a feeble current is passed, there ensues a movement of the digits of the corresponding limb. Now, by no shifting of the electrodes on the surface of that convolution can we obtain a movement of the whole hand at the wrist. Any shifting of the electrodes with that current produces only a movement of the digits, until, if we move them sufficiently far, we get a movement not of the hand but of the lips or feet. In short, we get out of the area of the hand-movements altogether. To get a movement of the hand we must keep the electrodes still and *increase the intensity of the current.* The significance of this observation seems to me to be this, that the centres representing movements of the hand, as a whole, are not on the surface of the cortex cerebri, but are *beneath* the surface. Be it said that the increased intensity of the current is required not to penetrate a stratum of tissue between the centre and the electrode, but because the larger muscle is represented in the larger centre, and the larger centre requires the stronger stimulus to discharge it? I reply that in this particular case the rule that muscles increase in size as the parts they move recede from the periphery does not apply, since the motors of the digits are as bulky as the motors of the wrist.

Seeing that the spread of the spasm to the wrist motors is *simultaneous* with its spread to remaining digits, it is difficult to see what other possible position the centres representing the former could occupy, for if they were laterally adjacent to the digit motors, then the discharge must pass through the latter to get to the former, which would therefore *succeed* them in discharging, and the spasm of wrist motors would be correspondingly successive and not simultaneous.

Moreover, if we accept the doctrine of Evolution, and agree that the centres for movements of the digits have been differentiated out of centres for movements of the whole hand, it appears manifest that the differentiated centres must be situated superficially to the parent centre, since that is not only the direction of least resistance, but the only position in which such centres could possibly find space to occupy.

On every account, therefore, it appears that while centres representing movements of the extreme periphery are most superficially situated in the cortex cerebri, centres representing movements one degree removed from the periphery are situated beneath or more centrally than the first.

It will be unnecessary to repeat these arguments to show that what is true of these two groups of centres is true also of all succeeding groups in their order from the periphery centrewards, and that the centres representing the movements of the several segments of a limb are superposed on one another; the centres representing the most central movements being most centrally situated, and those representing the more and more peripheral movements being placed one above another towards the surface of the brain.

Hence it appears that when there occurs a movement of thumb and finger, the discharge, starting from the centre in the cortex that represents that movement, passes successively through the subordinate centres representing movements at wrist, elbow, shoulder and trunk to reach its destination. When it is remembered that for a movement to be effectual it must start from a fixed *point d'appui*, the benefit of this arrangement will be apparent. For the discharge in passing through the subordinate centres produces in these centres a disturbance. It increases the residual discharge which is always in some degree flowing from them. Such residual discharge may not be sufficient to cause actual movement of the parts represented, but it braces up the muscles and produces a steady fixation of the whole limb, and this gives to the required movement a firm and stable foundation.

It was shown in Chapter III. that the smaller muscle is represented in the smaller centre, and as the peripheral movements are actuated by the smallest muscles, and as the muscles increase in size as they recede from the periphery, it follows that the most superficial centres are the smallest, and that the centres of subordinate layers increase successively in size.

Again, in Chapter V., it was shown that the movements of the digits and of the peripheral parts generally are immensely numerous and various, while as parts are more distant from the periphery, their movements become fewer and less diverse. And every distinct movement supposes and necessitates a distinct centre, so that the most superficial centres are the most numerous, as well as the smallest, and the centres most deeply situated are the fewest as well as the largest. From this it appears that the general arrangement of the cerebral centres is of an arborescent character. At the base are a few large centres representing the movements of the trunk. Above these and discharging through them are centres somewhat smaller and somewhat more numerous, representing the trunk-leg, trunk-arm, and neck movements respectively. Above these again are the centres proper to movements of each limb, and of the jaws and face respectively; each successive tier of centres representing a more peripheral segment of the body, and consisting of more numerous and smaller centres than the tier below it. Each centre receives on its upper surface the discharges of several centres above, and the discharge of each, together with those of several of its fellows in rank, impinges on the upper surface of the centre below.

It will be observed that the arrangement here attributed to the cerebral centres is precisely the converse of that which was found in the beginning of the chapter to be capable of effecting co-ordinations in simultaneity. From this disparity two conclusions may be drawn. First, that co-ordinations in simultaneity are probably not effected in the cerebrum; and second, that the chief motor function of the cerebrum is to effect co-ordinations in succession.

Let us see if the arrangement that we have supposed will suffice to affect any known normal sequence of movement. It has already been stated that no fixed arrangement of centres will account for the initiation of any set of movements. The original impetus must in every case be derived from without the centres engaged, and directly or indirectly from without the body. We have therefore to suppose an impetus applied to the system we have constructed, and to consider its effect. Let us suppose the impetus to be applied to the base of the arm series of centres, and to travel upwards towards the surface. It will produce movement of trunk, of arm, of elbow, wrist and fingers in succession. The particular series selected by the current will depend on the direction from which it comes, and on the subsidiary influences arriving from sensory regions, which direct its course, but it is evident that progress along one branch of the tree of centres from trunk to twig would produce in succession bending of trunk, stretching forth of arm, straightening of elbow, extension of wrist and of fingers. Now if the flow spreads to a neighbouring digital centre, and then turns back along the line, there may be bending of fingers, grasping of hand, bending of elbow, lifting of arm, straightening of trunk. Such are the sequential movements required for raising a weight. Suppose the weight is considerable, the necessary discharge must be considerable. Being so, it will tend, like all considerable discharges, not only to flow downward to muscles, but also to overflow laterally to neighbouring centres. In raising a heavy weight the chief strain is not so much in limb muscles, which merely make a hook to hang the weight on, as in trunk muscles, which do the actual lifting; hence the chief overflow may be expected to be from trunk centres, and into, of course, neighbouring centres. Hence we may expect, if the discharge is great, to see evidence of a discharge spreading from trunk centres up some other series. And in lifting a heavy weight what do we find? We find the *unemployed* arm lifted, abducted from the side, extended at elbow and wrist, and, according to the amount of weight lifted, even at the fingers. We find the head thrown back, the jaws clenched, and even the lips retracted.

Such an arrangement of nerve-centres as is here supposed will obviously account for the occurrence of all radial sequences. It will also suffice for lateral sequences. For if all the digital movements are represented in contiguous centres, it is easy to see how they may follow one another by lateral extension of the discharge; and the proximity, experimentally ascertained, of the arm and mouth, etc., centres, shows how readily a sequence may be directed from the one series to the other.

At this stage the reader will probably propound in his own mind the question why it is that, in sequences of movements, *one particular* movement and no other follows a previous movement. Take the instance already adduced. A leaning of trunk is followed by extension of arm in a particular direction. Why in that particular direction? The extension of arm is followed by extension of fingers. Granting that, by the arrangement of nerve-centres here supposed, *some* digital movement will follow movement of arm and wrist, why is it a movement of extension, and why is it followed by the movement of grasping the handle of the bucket that it is desired to lift, and not a movement as of picking up a pin, for instance? You have not shown, he may say, the arrangement of nerve-structure that brings about always the *appropriate* sequence of movement. The impatience evinced in the previous questions is a very natural one, but a little consideration will show that this is not the place, nor has the time yet arrived, at which an answer to them can be given. Any particular sequence of movements is directed, it is evident, to the performance of a particular act suited to a certain set of circumstances in the environment. The sequence of stretching the arm in that particular direction to that particular extent, and following it at that particular moment with a grasp of that particular strength, is adapted to the special circumstance of a full bucket in that particular position in the environment. Now the adaptation of a movement of the organism to circumstances in the environment is a question not in physiology but in psychology, and therefore falls to be dealt with in the succeeding part of this book. It is obvious that a sequence so purely special and individual in its character, and suited to a set of circumstances that has probably never been before presented in precisely the same form, cannot possibly depend on any *fixed* arrangement of nerve-tissue, but must be actuated by arrangements that are freely modifiable. A fixed arrangement can actuate only such movements as are continually repeated in the same form. Such movements are those of breathing, and to a certain degree also those of walking.

In the ordinary movements of breathing, it is the inspiratory act only that is to any appreciable extent affected by active muscular exertion. Expiration is mainly affected by the resilience of the tissues stretched in inspiration. The inspiratory centre is set in action, there seems to be no doubt, directly or indirectly by the condition of the blood that nourishes it. Deoxygenated blood appears to have the effect of discharging the elements of the centre. In this respect the working of the inspiratory apparatus is truly automatic, the cessation of the action bringing about directly the very state of things that is necessary once more to set it going. The constitution of all nerve-centres being similar, it would be strange indeed if this were the only centre amenable to this influence, and the fact that strangulation produces general convulsions is sufficient to show that all motor centres possess in some degree this property of being discharged by contact with deoxygenated blood, and that the inspiratory centre is merely specialised so as to be somewhat more sensitive to this influence than the remainder of the nervous system.

The mechanism of walking is also one which from its sameness, regularity and automaticity may be supposed to be actuated by a fixed arrangement of nerve-tissue. In this case the movement once begun goes on without further attention on the part of the individual, that is without the intervention of any influence from the higher centres save such as is required for general guidance as to speed and direction. The separate component movements are truly automatic. In this case we must suppose that there are separate but connected centres for the several movements of which walking is composed, and that their arrangement and structure are such that each at the termination of its own action supplies a stimulus which initiates the action of the other. Such a mechanism has become more readily conceivable since the invention of the Maxim gun. In this machine the recoil of one discharge not only supplies the power necessary for reloading and cocking the gun, but actually provides for the pulling of the trigger at the appropriate moment. If we imagine two Maxim guns performing these offices reciprocally for one another, we have an exact analogy to the mechanism by which we suppose the movements of walking to be actuated. The Maxim gun, it will be remembered, can be so controlled as to stop and go on as required, to fire any number of shots per minute, from six up to six hundred and sixty-six, and it can be laid in any direction while in full work. In this respect the operator stands in the same relation to the gun as the higher nerve-centres stand to those which constitute the mechanism of ambulation.

What is true of the mechanism of walking is true of every other motor mechanism in which the movements follow in automatic sequence; each discharge producing its own proper movement, and giving, as it were, a parting kick, which sets the next centre discharging, and the next movement going. Such sequences are seen in many handicrafts, in playing on musical instruments pieces learnt by heart, in reciting compositions similarly learnt, etc.

The reference above made to higher nervous-centres requires explanation, and introduces us into a new department of the subject of co-ordination. We have hitherto spoken of motor centres as if such centres were purely motor, with no other function than that of producing muscular movement; and such treatment is necessary to place the matter clearly before the reader. But this isolation of the motor function is imaginary, and does not exist in fact in nature. We have considered the motor function solely, as the mathematician treats of the lever. He neglects the weight, the thickness, the resilience of the lever, and imagines it as a rigid line. And thus he discovers the fundamental problems of leverage. Similarly the neurologist neglects for the time being the secondary qualities of the motor centres, and considers them as purely motor, while he traces out their purely motor functions. But there is no such thing in physiology as a purely motor centre, or a purely sensory centre. By a motor or a sensory centre we mean only one in which motor or sensory functions preponderate. And every centre has other functions still besides those of receiving impressions and issuing stimuli to movement.

The mechanisms that we have hitherto dealt with have been those for producing movements that are completely organised,—that is to say, movements which have been and have to be repeated very many times in substantially the same form. Such are the movements of breathing, of walking, of repeating actions that have been learnt by heart. But we have said nothing hitherto to account for an entirely new movement that has never occurred before. However frequently an action may have been repeated, it is rarely that every repetition is precisely the same as its predecessors, and on many occasions the deviation from the former act will be noticeable. In the case of walking, for instance, while the movements of the legs are very nearly the same as on previous occasions, there will be modifications introduced from time to time in going uphill and downhill, in altering the direction, in stepping over obstacles, in varying speed, etc., and these alterations cannot, it is obvious, be effected by anything in the mechanism of simple ambulation that we have hitherto considered. No internal arrangement of any centre will enable it to adapt its action from time to time in accordance with varying external circumstances. The modifying influence must in all cases come from without. The question is whence and in what form does the influence come to the twin centres that we have supposed to be concerned in walking, which modifies the action of these centres in accordance with external circumstances? It has been hinted above that the influence comes from "higher centres." What, then, is the meaning of this expression?

Once set going, the twin centres will keep each other in alternate action until arrested, but in this as in all other cases, some influence from without is required to begin the action. This initiating impulse must either come from a diffused wave, permeating all the centres at large, or it must come from a specific source in a specific direction. That it is not the result of a diffused wave is easily shown, for such a wave will set in action, first and most, the smallest, most mobile, most peripheral parts (Chapter III.), which are not the parts concerned in walking. Hence the originating impulse must come from some specific source. In other words, there must be outside the ambulation-centres a nervous region or centre whose action serves to bring these centres into activity; and there must be a region or centre whose action serves to arrest or inhibit that of the ambulation-centres. These two centres would together control the action of the ambulation-centres, and by combinations of their action in various proportions could cause the latter to start into action, to act faster or slower, or to stop altogether. Having the control of the ambulation-centres, the latter would correctly be termed subordinate, and the former superior, or higher. It is in this sense that the term higher centres is employed. It is quite conceivable that the two functions of origination and acceleration on the one hand,

and of retardation and arrest on the other, may be carried out by one and the same centre acting in different ways. If we suppose the functions to be combined in a single centre, we shall have arrived at a mechanism composed of three centres—two twin subordinate and one superior or controlling—by which the movements of walking can be begun, continued at varying speeds and arrested. It is evident that a small further modification will supply the mechanism necessary for turning to right or left. But now comes the question, By what means are these superior centres in their turn set in action? Granting that the movements of walking are actuated by the mechanism described, how does it happen that these movements are begun at the right moment, varied in speed and direction according to the exigencies of the road that is followed? Here it is clear that we enter upon an entirely new class of consideration. We leave the consideration of actions carried on entirely within the body and enter on the consideration of the way in which actions of the body itself are adapted to the circumstances existing outside of it. And in taking this step we have left the domain of physiology and entered that of psychology. These problems will be treated of hereafter in the chapters on the psychological functions of the nervous system. In the meantime there are circumstances which enable us to add another storey to the building we have already raised. When a man is walking along the streets, taking the appropriate turnings, stepping from the kerb on to the roadway, and from the roadway back on to the kerb, he is adapting the movements of walking directly to the conditions in the environment, and so is exercising a psychological function. But when he gets up from his chair in order to go round to the library and get a book that he wants, the initiation of the movement is no longer *directly* adapted to the circumstances in the environment; for the existence of the book in its position in the library is not directly evident to his senses. He starts to get the book because he *remembers* where it is,—that is to say, he has a revivification of the nervous processes which were aroused in him by the sight of the book in a certain position in a certain house in a certain street. Now observe. These processes thus revivified are not in the twin ambulation-centres, nor are they in the upper walking-centre, for the memory is not directly one of walking, but one of seeing. The revivified processes are in a new and different region altogether; and it is these revivified processes which start the act of walking. Hence we are bound to infer that the discharge from the centres in which these processes occur is the initiating impulse which starts the upper walking-centre, which in its turn starts the twin ambulation-centres, which set going the movements of walking through the primary muscular cell-groups.

It appears, therefore, and this is the most important conclusion that we have yet arrived at, that the nerve-centres that actuate and regulate, directly and indirectly, the movements of walking are arranged in a hierarchy, each centre controlling and regulating those that are below, and being controlled and regulated by those that are above it. There is nothing anomalous or paradoxical in the supposition that the same centre affords both the impulses which start and accelerate, and the impulses which retard and arrest, the action of inferior centres, for we have daily illustration of a similar condition of things in every business organisation. Take the case of an army, for instance. The rank and file under the orders of each corporal are at the same time subject to his control, which inhibits them from acting, and subject to his initiative which starts them into action. And as the rank and file to the corporal, so is the corporal to the sergeant, the sergeant to his immediate superior, and so on throughout the military hierarchy up to the commander-in-chief. And this is no mere fanciful or far-fetched analogy. It is a close and apposite illustration. For the whole military machinery may be actually regarded in the light of a nervous mechanism. It is by the direct action of their nerve-centres that the officers conceive and issue their orders to their subordinates, and it is by the action of their respective nervous systems that the subordinates receive these orders and carry them out. The analogy is closer still. For with orders or without orders the soldiers are continually under the influence of the military discipline, which inhibits them from taking upon themselves any independent initiative, and which provides that on the completion of any active order they shall subside into an attitude of quiescent expectancy. This continuous condition of inhibition or control is from time to time broken by behests to activity, precisely as the similar continuous inhibition of the nerve-centres is similarly broken.

Again, just as the purely local stimulus of a mote on the eyeball is responded to by the purely local action of a blink of the eyelid, actuated by a single centre of the lowest rank; so the purely local stimulus of the single footstep is responded to by the purely local action of the sentinel's challenge, delivered by an individual of the lowest rank. The analogy may be carried into much further ramifications. Though no further action follow the blink of the lid, yet the occurrence of the tickling feeling proves that the stimulus was carried beyond the local and subordinate centre up to centres far higher in rank. And though no further action follows the challenge of the sentry if it be satisfactorily answered, yet the occurrence is reported and comes to the knowledge of far higher authorities. If the grain of dust is not dislodged by the blink, but remains as a cause of irritation, further action soon follows. The stimulus is irradiated from the local centre to centres higher and higher in rank, and is now intense enough to set these higher centres in action; so that the hands are brought to the help of the lids, and if they do not suffice to get rid of the intruder, the voice requests help, and the whole body moves towards the source of relief. Similarly, if the sentry's challenge does not suffice to arrest the intruder, and his attitude is menacing and indicative of support behind, the alarm given by the sentry to his superiors is followed by action on their part. The guard turns out, the regiment is aroused, supports are sent for, the whole army may be set in motion, and a general engagement may ensue.

The parallel may be pushed further yet. A minute mote falling on a normal eye causes a single blink, and the intruder is removed, the action ceases. But the same mote falling on an inflamed eye causes a much more lively stimulus and a much more vigorous reaction. The sensation, instead of being insignificant, is acutely painful. The single blink is replaced by copious action of lids, and hands, and effusion of tears. As the inflamed eye to the normal eye, so is the army in the field to the army in time of peace. In the latter case the intrusion of a single stranger produces no reaction beyond what is necessary to keep him out, but the same occurrence in the face of the enemy causes a general commotion. No longer confined to the guard-room, the intelligence of the intrusion is conveyed to headquarters, and a general commotion results from the arrest of the spy.

The similarities are far from being yet exhausted. The private soldier has nothing to do with the supplies save only to take to himself the rations and clothing that are served out to him. Each subordinate officer is responsible for the condition of the clothing and accoutrements of those under his command. The colonel of the regiment, from whom proceed both the initiative to action for the whole regiment and the discipline which maintains the whole regiment ready to act, is further responsible for the supply of food, clothing and arms for the whole of his regiment. The same combination of functions that the colonel fulfils towards his regiment, the general fulfils for his brigade, the superior general for his division, and the commander-in-chief for the whole army. It is the same with the nerve-centres. Each of the lowest centres of all not only effects a movement, but at the same time governs the nutrition of the parts that effect that movement; so that when a motor nerve is cut, the muscle wastes. Each higher centre effects not only the control and the initiation of all centres beneath it, but their nutrition as well, and not only their nutrition, but also the nutrition of the mechanisms that they serve. So that while the lowest centres control the nutrition of (say) muscles only, the higher control the nutrition of the lower centres; and thereby, in a more general way, the nutrition of the muscles that the lower centres actuate; and thus control, moreover, the nutrition of bones, ligaments, etc., that are subsidiary to the movements that they directly effect. And as the commissariat is under the orders of the commander-in-chief, who governs through it the supply of nutriment to the whole army in general though not in detail, so the highest centres regulate generally, but not in detail, the nutrition of the entire organism.

If the nervous system be constituted as is here supposed, then the parallel that is now suggested will hold good not only in health but in disease. Let us consider the analogous cases and see if it do so apply.

If the sentinel is killed, he can no longer issue his challenge to the intruder, nor communicate the alarm to headquarters. And if the reflex centre is destroyed, if, for instance, the frog is pithed, the usual stimulus provokes no reflex action, and no sensation corresponding to the stimulus is felt. On the other hand, suppose the sentry is excited by drink. He is met by the patrol, and in an excess of zeal he challenges and straightway bayonets his comrade. Similarly, if the frog be strychnised, a slight and ordinary stimulus produces an excessive and extraordinary reaction.

Suppose it is the sergeant that is killed, which may be considered equivalent to having the cord bruised. The first consequence is that the rank and file receive no orders from their superiors, the sergeant who was the transmitter of the orders being killed. Consequently they remain inactive, but they are capable of again taking part in the military operations if the messages are sent by another route, or a new sergeant appointed and the communication restored. Similarly, when the cord is bruised, the centres below are cut off from communication with the centres above, and no voluntary movement becomes possible. But the inferior centres are themselves intact, and are capable of resuming their part in the bodily operations if the cord recovers, and communication is restored. There will be a second consequence of the loss of the sergeant, in the relaxation of discipline which he was instrumental in maintaining. His control being removed, the soldiers will be apt to get uproarious and exceed their duty. And when the control of the superior centres is removed by bruising of the cord, the reflex centres overact, and reflex action becomes excessive. Further, as the sergeant is no longer present at the daily distribution of food, the interests of his men will probably suffer, and the amount served out to those who have been under his charge will be diminished. Similarly, when the cord is bruised and the legs are paralysed, their nutrition begins immediately to suffer. At the end of twenty-four hours it is apparent that the muscles are flabbier, the skin looser and sweatier than normal.

Now let us suppose that the colonel is shot at the head of his regiment. For a short time the regiment is demoralised. It is thrown into disorder and begins to retreat. In a short time these effects pass off, and then it is found that the state of affairs is as follows:—The severance of the chief channel of communication between the regiment and the commander-in-chief will greatly impair the value of the regiment to the army at large. The daily routine of the regiment will not be much affected. That is carried out by the subordinate regimental officers—by the majors, captains, etc.,—and will be carried on in much the same way whether the colonel is present or no. The daily drills will be performed, the parades held, the canteen will be open, and the messes served as usual. The general knowledge of regimental duties attained by the inferior officers will suffice to carry the regiment through the simpler duties that are required of it on the march. But when there is a prospect of an engagement, when very special and precise and important and perhaps novel movements have to be carried out in the face of the enemy, then the loss of the guiding spirit is felt. When the skilful handling of the regiment, with reference to the particular nature of the ground and the presence and strength of the enemy, becomes of the first importance, then the want of a single, firm, decisive, experienced authority becomes patent. Compare these facts with the facts of paralysis from a small clot in the corpus striatum. Such a clot produces first a general shock with total paralysis of, say, the right arm. This corresponds with the initial retreat of the regiment and its virtual paralysis. When the effects of the shock pass off, it is found that the arm is much weakened, and that it is weakened in such a way that the digits are altogether paralysed, the hand less so, and that the power of movement increases as we leave the periphery, while at the shoulder no defect of movements can be found. In other words, what are lost are the most peripheral movements,—that is to say, the movements that are most precise, most elaborate, most special, most important, and most novel; while the movements that are least affected are the most general, the most automatic, the simplest, and the most frequently repeated. The parallel holds good in all respects, and it may be carried further. For loss of the colonel involves the omission to send in requisitions for clothing and stores. The daily rations are distributed as usual, and the regiment does not suffer at once, but as the clothing and stores become worn out they are not replaced, and thus, after a time, the condition of the regiment suffers. So with the hemiplegic limb. At first little change in it is apparent, but after a time it wastes. The loss of the colonel will not have a very apparent effect on the discipline of the regiment, for that will be maintained in a general sense by the other regimental officers; nevertheless, it must be to some slight extent impaired; and correspondingly, while in hemiplegia we do not find reflex actions very much increased, we do find the muscular and tendon reflexes slightly increased.

Suppose now, that in the excitement of battle the colonel loses his head. He begins to send out messages to his skirmishers faster and faster. No sooner is one order sent than another follows to contradict it, another and another and another follow as fast as the messengers can succeed one another. The consequence will be that the soldiers will run first to execute one order, then to execute the next, until, as different orders come, one after another, faster than they can be carried out, the soldiers will be raised to a state of high excitement; and after a good deal of aimless running to and fro, they will at length stand still and do nothing, and finally cease acting from exhaustion. The occurrence is parallel to a fit of Jacksonian epilepsy, which begins with the hand trying, as it were, to execute many movements at once, goes on to moveless rigidity, and ends in motionless exhaustion.

We will now transfer our observations to a higher level, and consider the result of the loss of the commander-in-chief. In actual life no doubt the loss would be supplied by sending out another commander-in-chief from home, but we must suppose not only the individual lost but the function suppressed. What will be the result? The result will be that while the army maintains its general organisation intact, and while all the routine duties of regiment, brigade and division, of horse, foot and artillery are carried on much as usual, yet for campaigning purposes the army is useless. It ceases to be an assistance to its allies, a defence to its country, or a menace to its enemy. A civilian passing through its ranks and seeing everywhere the evidence of order and discipline, the trenches manned, and the sentries posted, would see no evidence of any important defect in the army. But although no defect might be seen by the civilian, the practised eye of a military observer would see that something was wrong. He would observe a languor, a want of initiative, a failure to take advantage of opportunities. Though the army might be marching in the right direction, its several divisions, perfect in their internal discipline, would not be so handled as to support one another at proper times and places. In case of an engagement, the whole army takes part, led by its generals of division, the soldiers fight gallantly, the guns are well served, the charges brilliantly delivered, one whole wing may be successful in driving back the enemy. But in the absence of a single guiding hand the result must be disastrous. The tactics may be admirable, but the strategy must fail. If there occur no general engagement, it may be long before the army is destroyed, but in the absence of a definite aim and plan, the inferior commanders become discouraged and lose their interest; the discouragement and lack of interest spread rapidly downwards from rank to rank until the whole army is disheartened. Then ensues desertion, cutting off of stragglers, failure of supplies; and soon dysentery sets in, and sooner or later the army melts away.

Corresponding to the commander-in-chief of the army are the highest of all nervous-centres,—those centres whose function it is to actuate the movements and regulate the nutrition of the body as a whole, and whose activity is accompanied by consciousness. When these centres and these alone have their functions abolished, as in the early stages of drunkenness and of other forms of coma, what do we find?

To the superficial observer and the layman, who are comparable with the civilian in the example, the difference is not great. As in the one case the local and routine duties are efficiently performed, so in the other are the local and vegetative functions. As in the one case no part of the army is perceptibly defective, so in the other no part of the body is conspicuously paralysed. The languor, the want of initiative, the failure to take advantage of opportunities on the part of the army is paralleled by the heaviness, the dulness, the defect of intelligence on the part of the individual. It may happen that the divisional commanders of the army are actuated by mutual jealousies and suspicions, and that when the controlling hand of the superior is removed they fall out, quarrel, attack one another, and diffuse throughout their several divisions the excitement which they themselves display. Or it may happen that, their ardent spirits no longer held in check by the wisdom and authority of their chief, they launch out into reckless enterprises, in which their troops become speedily exhausted or meet with disaster. Similarly, when the highest nervous centres are thrown out of gear, the most prominent symptoms of the loss may be an outbreak of violence or a clamorous exaltation, and this is due, it may be contended, to the uncontrolled action of centres immediately subordinate to those whose function has been lost. Such occurrences are common in the early stages of drunkenness, of insanity, and of other forms of coma.

But whether the immediate effect of the loss of the highest authority is an outbreak of excessive but misdirected vigour, or whether it is a general condition of diminished activity, in either case the ultimate result is a loss of efficiency on behalf of the body at large. We have seen how in the army the routine of discipline may be retained and the routine operations carried on, and that in the body the vegetative functions are preserved, but in both cases the highest functions, which are necessary for the conservation of the organism as a whole, are lost. The march of the army is continued, but when it arrives on the field of battle the want of a coherent plan of operations loses the day. Similarly the individual in an early stage of drunkenness is competent to get to his office, but when he is there he is unable to transact business efficiently. The army without a chief becomes a *quantité négligéable* both to friends and foes; and similarly the man who is indulging in a drunken debauch is useless. Although no one part of the army is actually disorganised, and no one limb of the body is paralysed, yet throughout the whole of each body there is a languor, an inability for sustained exertion, an impaired efficiency, which, considered from the present point of view, may be regarded as a paresis of the entire organism. It is not conspicuous in any one member, because all being equally affected, the emphasis of contrast is lacking; but if we compare the organism as a whole in its present condition with itself in its former condition, or with other similar organisms that are unaffected, it becomes at once apparent that there is a universal defect of efficiency, which in both organisations may be ascribed to the withdrawal of the stimulus of frequent positive impulses to different and new exertion—a withdrawal which is followed in both organisations by disheartening, discouragement and diminished inclination to exertion.

The lack of initiative, the feebleness, and the possible uproar from absence of the controlling authority will be the most conspicuous, but they will not be the only effects of the removal of the highest functions either in the one organisation or in the other. In the army the supply of arms, ammunition, accoutrements, clothing stores and food depends on the requisitions sent home to the War Office by the commander-in-chief. If the commander-in-chief ceases to exist, stores will still be sent out, no doubt, but they will be sent in wrong proportions, haphazard and by guesswork—too much of this and too little of that. Arrived at the army the commissariat officers, sharing in the general inefficiency and carelessness, the distribution will be similarly faulty. Here will be carbine ammunition served out to infantry regiments, there will be cavalry soldiers with shoes instead of boots; in another place, horse-shoes provided for a camel regiment. The distribution of food, too, will be badly done. The consequence will be that the army will suffer not only in efficiency but in physique. The men being badly shod, badly clad, and badly fed will soon deteriorate in health. In the individual, too, loss of the highest nervous function invariably causes mal-nutrition. In drunkenness and in insanity the skin becomes altered in tinge, becomes unduly dry or unduly moist; the hair is harsh and staring, or less often dripping with moisture; the nails are affected; the bowels are constipated; the breathing, the pulse, the urine are altered. To sum up, the three main consequences of loss of the commander of an army are lack of initiative, lack of control, and modification with impairment of supplies. And the three main consequences of loss of the highest nerve-centres are lack of initiative, exaggerated action, which is a consequence of lack of control, and modification with impairment of nutrition. Here, therefore, the parallel between the military organisation and the organisation of the nerve-centres still holds good. It yet remains to compare the opposite error, the fault of over-action, and see if the same holds good.

Suppose the commander-in-chief to become highly excited, and to issue orders in great excess. The result will be an excess of activity on the part of the army at large, but will vary with the degree to which the orders are excessive, and with the directions in which they are issued. A multitude of contrary orders following one another faster than they can be executed will have the same effect when issued by the general to the whole army as when issued by the colonel to the regiment. They will produce a great excess of activity, culminating in a standstill of consternation, which is analogous to a convulsion. But in the present case the confusion and dismay will affect, not merely a regiment, but the entire army; and a convulsion from excessive discharge of the highest centres affects not a limb only but the entire organism. If the orders are less excessive than this, but still very numerous and urgent, the effect will be a great excess of activity on the part of the army at large—activity which will be well or ill directed, beneficial or the reverse, according to the nature or wisdom of the order, but which will be excessive to the point of fatigue or to the point of exhaustion, according to the numbers and urgency of the commands. The analogous condition of the individual is excitement, culminating, it may be, in mania.

To recapitulate. Co-ordination of movements in sequence is effected in the cerebrum, in which the centres are arranged generally in a hierarchy, the lowest centres representing but simple movements of a small part of the organism, representing that part very strongly and directly, and representing but little else, and that little faintly. The intermediate centres re-represent the parts that are represented in the lower centres. They represent more elaborate movements of a larger portion of the organism. The highest centres re-represent all the parts that are represented in the middle and lowest centres, they represent the most elaborate movements of the entire organism. To put the matter in brief but somewhat crude form: the lowest centres represent movements, the middle centres represent acts, the highest centres represent conduct.

Seeing that all co-ordinations are divisible into two main groups,—co-ordinations in simultaneity and co-ordinations in succession,—and seeing that co-ordinations in succession, which form the larger group, consisting of the more numerous, the more elaborate, the more complicated movements are effected in the cerebrum, which is the larger and the more elaborately constructed of the two great divisions of the brain; it is natural to conjecture that the other smaller group of simpler co-ordinations is effected in the smaller and more simply constructed division of the brain —the cerebellum.

In support of this conjecture there is a large body of evidence from various sources. In the first place, it has been determined experimentally that the cerebellum is the organ for effecting equilibration. But equilibration is, as we have already seen, effected entirely by movements co-ordinated in simultaneity. It is, in fact, the most complete and most conspicuous example of this form of co-ordination, and is therefore sure to be the most conspicuously defective when all co-ordinations in simultaneity are abolished. That other functions are represented in the cerebellum is manifest from the spasm of the masticatory muscles observed in cerebellar lesions. The movement of the jaws can have no equilibrating effect; but these movements are conspicuous examples of co-ordination in simultaneity, and they belong to the central group of movements, in which such co-ordinations predominate.

Spasm due to lesion of the cerebellum is in all respects the antithesis to Jacksonian epilepsy. In Jacksonian epilepsy the spasm begins at the extreme periphery—at the lips, fingers, or toes. Cerebellar spasm begins in the most central muscles. It produces first opisthotonos and retraction of the head. Jacksonian epilepsy spreads centripetally up the limbs to the trunk. Cerebellar spasm spreads centrifugally from the trunk down the limbs. In Jacksonian epilepsy the spasm is always clonic in character. It is always jerky, intermittent, coming on in sudden paroxysms, interrupted by periods of complete absence. Cerebellar spasm is continuous. Just as the action of the trunk-muscles, which maintains the erect posture, is always present in some degree, and is from time to time increased to subserve the necessities of movement, so the spasm of cerebellar disease, affecting precisely the same muscles, is continuously present for days and weeks together, and is subject from time to time to exacerbations, which are not clonic or sudden in character, but are of gradual rise, progress and decline. When the normal action of trunk-muscles is increased, as in rising from a recumbent posture, it is associated with action of the limbs—an action not of the periphery, but a large and general action of the limbs as a whole. And when the cerebellar opisthotonos undergoes an exacerbation, it spreads down the limbs, but does not, except in the most extreme cases, involve the hands or feet.

Whether in their tonic and chronic character, or in the muscles in which they originate, or in the order of their spread, convulsions of cerebellar origin are in every respect the exaggerated counterpart of "central" movements,—that is, of movements that are co-ordinated in simultaneity.[1]

Thus we find that the functions of the cerebrum and cerebellum are antithetical and complementary to one another. The cerebellum represents first and most the most central muscles, and the intensity of representation decreases towards the periphery. The cerebrum represents first and most the most peripheral muscles, and the intensity of representation diminishes towards the centre. The cerebellum maintains a continuous same action, the cerebrum breaks up the continuous same action into interrupted and various movements. The cerebellum actuates co-ordinations in simultaneity, the cerebrum actuates co-ordinations in succession. The cerebellum regulates co-ordinations in Space, the cerebrum regulates co-ordinations in Time.

[1] According to this doctrine, a yawn is a wave of cerebellar influence. Beginning with extension of the trunk it spreads with a continuous gradual increase to the muscles of the jaws, where it produces a gape, and to the limbs, in which it produces the attitude of extreme extension.

PART II

FUNCTIONS OF THE NERVOUS SYSTEM

PSYCHOLOGICAL

CHAPTER VII

CONDUCT

By the psychological function of the nervous system is not meant its connection with Mind—with mental states or consciousness. At present we are dealing with objective psychology only, and objective psychology is not at all concerned with consciousness. It deals, as has been said, with matter and motion. The subjects of which it treats are the dispositions and movements, molecular and molar, of parts of the organism with respect to one another, or of the organism as a whole with respect to its environment. The molecular movements that take place in the nervous system present problems in molecular physics, and have been considered in the chapter dealing with the functions of the nervous system from their physical aspect. The molar movements of the parts of the organism with respect to one another present problems in physiology. They are affected by the muscles upon the initiation and under the regulation of the nervous system; their investigation falls to the province of the physiologist, and they have been treated of in the chapters on the functions of the nervous system in their physiological aspect. From a psychological point of view the function of the nervous system is to effect the adjustment of the organism as a whole to its environment—a process concerning which a good deal of misconception prevails.

When we speak of the adjustment of the organism to its environment, we are dealing with three separate concepts, each of which must be clearly apprehended. It is necessary to have a clear idea of what is meant by the organism, of what is meant by the environment, and of what is meant by the adjustment of the one to the other. Acceptance of the term "organism" does not necessarily commit us to the doctrine that man's physical structure is a mechanism "played on" by his Will as a performer plays upon the organ; nor does the term environment denote merely the room in which a man sits, as one of my critics appears to suppose. The meanings of these terms, as they are ordinarily used in biological and psychological writings, are quite well understood and agreed upon; but as there is not, as far as I know, any formal definition of either of them, and as they are frequently interpreted in a sense very remote from that in which they are used in such writings, it will be expedient to explain the meaning which is attached to them in this book.

By "the organism" is meant here the individual human being. Of course there are many other organisms besides the one under consideration. Not only is every individual living being, animal or vegetable, an organism, but there are other organisms that are not individual. For instance, Mr. Spencer's masterly arguments demonstrate that a society of human beings is, in no metaphorical sense but in the strict meaning of the term, an organism; and Darwin, though he did not use the term, arrived at a similar conclusion with respect to communities of animals, as of bees and ants. It will be necessary occasionally to speak in these pages of other organisms than the human individual, but in such cases the context will clearly indicate the variation of meaning. In the absence of qualification the term organism is to be understood as synonymous with "individual human being."

Such being the meaning attached, a further question arises as to whether the connotation of the term includes both body and mind, or the body only. It scarcely needs be said that it necessarily includes the body. Scientific psychology has not yet arrived at the investigation of the conditions of existence of disembodied souls. But does it include the mind also? This is a question which can only be asked by those who have not assimilated Mr. Spencer's definition of the nature of mind. That definition is that every phase of mind is a feature in or a factor of the correspondence between the organism and the environment. The investigation of mind belongs therefore neither to that of the organism nor to that of the environment, but to that of the adjustment of the one to the other. To say this is not to say that when in psychology we regard the organism, we regard it as destitute of mind. Objective psychology has nothing to do with consciousness—with thoughts and feelings. In the dealings of objective psychology feelings are not recognised save on their objective aspect as states in the organism; thoughts are not dealt with save in their substrata as processes in the organism; and such states and processes are aggregated with multitudes of other states and processes to make up our concept of the living organism. We do not consider the superior nervous processes as *parts* of the individual any more than we consider the circulation of the blood as part of the individual. When we regard the organism we regard it as a living structural aggregate in which countless functions are being carried on, and among these functions is—not mind, but that aggregate of states and processes in the superior nervous system, which is the substratum of mind.

Every one who is accustomed to the use of the term in scientific work has a fairly definite notion of what is meant by an organism, and by the human organism; but with the term environment it is far otherwise. Some writers, or at any rate some readers, understand it to mean the room in which a person lives; others extend it to his house and grounds; while yet others extend it to his neighbourhood. In none of these senses is the term used here or in the writings of psychologists generally. The significance that these attach to it is very far wider than any of the meanings that have just been given. In psychology a person's environment means *the whole of the circumstances that act upon him* *or that he can act upon.* It matters not whether the circumstances are far or near, physical, social or moral, known to him or unknown, manifest or hidden. If they can act upon him, however indirectly, they are part of his environment. If he can act upon them, however remotely, they are part of his environment. The public opinion which compels a statesman to propose a law for punishing dynamitards, is as much a factor in his environment as the furniture of his room; and the miscreants who suffer under the operation of the law are as much a portion of his environment as the coals that he puts on the fire. In space a man's environment extends from his shirt to the furthest nebula whose light falls upon his eye, and to the deepest stratum of the earth whose existence he can infer. In time it extends from circumstances in the remotest past that he can conceive to the remotest future circumstances that he can forecast. In complexity it varies from the bread he eats and the water he drinks, to the social, political and religious surroundings in which it is his lot to live. To say that a man's environment extends to the whole universe would be too comprehensive a statement; but it is scarcely an exaggeration to say that it may extend to a considerable portion of it.

Such a vast assemblage of circumstances as are included in the environment cannot be profitably treated as a whole, but must be split up into groups of manageable size before it can be usefully dealt with. The lines on which such a division must be made are tolerably obvious. The whole environment of each individual may be looked on as the aggregate of several special environments. There is first the *Physical environment*, including all the external circumstances which directly affect his bodily health. Such circumstances are the climate and soil on which he lives, the quality of the air that he breathes, the nature of his food and drink, the dryness or dampness, wholesomeness or unwholesomeness of his dwelling, of his occupation, and all circumstances of a like nature. Then there is what may be termed his *Vital environment*, by which are meant all the circumstances that affect his livelihood. In these are included the nature of his occupation, the scarcity or abundance of employment, the rate and kind of his remuneration, the degree of his dependence or independence, the character of his employers, of his official superiors, the tenure under which he holds his position, the precariousness or certainty of his lot, the state of markets, the demand for commodities, the facilities for and obstacles to commerce, the vagaries of fashion, the amount of leisure that his occupation leaves him, the proportion of his energies that it absorbs. A third class of circumstances with which men have to deal are those which are constituted by their family relations—the *Family environment.* These are the circumstances as to marriage, as to parentage, the existence of children, of other relatives, the degree of dependence or independence obtaining among them, the help or hindrance that they afford to the individual in the struggle for life, the laws and customs which regulate his dealings with them. The political system of which he is a member constitutes a fourth class of circumstances which may be termed his *Political environment.* Under this head are included not merely the question whether he possesses the franchise and the degree in which he shares in the legislation of his country, but, what is more important, the amount of certainty with which the fruits of his labours are secured to him. Other circumstances included in the political environment are the relations of his nation with respect to other nations; the state of peace or war, amity or antagonism; the prevalence of peaceful or bellicose feelings; the existence and nature of treaties. The *Religious environment* includes not merely the particular sect of which he is a member, the tenets that it holds, the amount of fervour that prevails in it, but the general tone of religious opinion in his community as exhilarating or depressing; the tendencies to conformity or independence; the degree of indifference or fanaticism prevailing. Other groups of circumstances, æsthetic, recreative and other, could easily be formed, each of which might merit description as a special environment, but the foregoing are by far the most important, and the aggregate of all the circumstances of all these special environments constitutes "the environment" which is spoken of in this book.

It is scarcely necessary to point out that the environments of no two people are precisely alike. No observation is more trite than that no two people are placed in quite the same circumstances; but it requires some consideration to realise how enormous the difference often is between the environment of one individual and the environment of another. So much attention will be bestowed upon these differences in subsequent paragraphs that they need not be further referred to now.

Such being the meanings that are attached to the terms "organism" and "environment" respectively, it remains to explain what is meant by "the adjustment of the organism to the environment," a phrase which science owes to Mr. Spencer, and one which is daily coming more and more into use. When the fur of a hare grows thicker and longer at the approach of winter, this change in the animal organism is specially adapted to the change in the climate in which it lives. It is a readjustment of the structure of the animal to the circumstances which act upon it—to its environment. When the hare runs away from a greyhound, its flight is regulated in accordance with the pursuit of its enemy. The hare is adjusting its movements to the special set of circumstances constituted by the presence and pursuit of the hound; it is adjusting itself to its environment. Animals which inhabit the recesses of dark caverns have no eyes. In the absence of light the eye is useless. The whole structure of the eye is arranged with reference to the existence of ethereal undulations in the external world; it is an adjustment of the structure of the organism to circumstances in the environment. When the cricketer or the tennis-player strikes at the passing ball, his act is timed and regulated with reference to the direction, speed and weight of the ball, and to the direction in which he wishes to send it. It is timed and regulated according to the circumstances of the occasion; it is an adjustment of his organism to its environment. When an astronomer turns his telescope to that spot in the heavens at which he has calculated that a star will be visible at a certain moment, and makes his observation at the time fixed upon, he is regulating his movements according to the apparent movements of the star. He is adjusting his movements to movements in the environment. Every man who gets himself vaccinated is procuring a change in his constitution adapted to the existence in the outside world of the contagium of smallpox. He is procuring the adjustment of his organism to a set of conditions in his environment. The various incidents of a day's work are so many adjustments of acts of the organism to conditions in the environment; and the aggregate of the work of a day, a year, a lifetime, is one great adjustment of the conservative and accumulative powers of the organism to the deteriorative and disintegrative action of the environment upon it. The performance of his duty is a set of acts by which each man adapts himself to the social conditions in which he lives. The deliberations of the judge, the speeches of the statesman, the dealings of the merchant, the calculations of the clerk, the handicraft of the artisan, are so many operations performed in adaptation to the requirements of their immediate employers on the one hand, or of that larger and more remote body of employers which is constituted by the public at large. The dicta by which the judge regulates the proceedings in his court, the artifices by which the statesman seeks to influence the minds of his audience, the haggling of the merchant for a more advantageous price, the steps in the clerk's calculation, the devices by which the artisan overcomes the obduracy of his material, are so many cases of adjustment of the organism to more proximate circumstances in the environment. The movements of the hand and of the organs of utterance are again adjustments of the organism to environmental circumstances still less remote—to the form and consistence of the material he uses, or to the distance of his hearers. Even the commonest, the most constant, the least conscious of our movements come under the same category. The accommodation of the eye is an adjustment to the varying distances of objects in the environment. The movements of breathing are adjusted to the presence of the air in which the organism is immersed, to its pressure and oxidising properties. They are part of the means by which the organism is adjusted to the multifarious circumstances by which it is environed. They are instances of the adjustment of the organism to its environment.

The foregoing examples, few as they are, are enough to show that the adjustments of the organism to its environment comprehend immensely numerous and varied phenomena; and that every detail of structure, every item of function of the organism, may be regarded as either "a feature in or a factor of the correspondence" between the organism and its environment. It will be apparent also from these examples that it is not every form of adjustment of the organism to its environment that falls within the province of psychology. The thickening of the hare's fur at the approach of winter is a very striking adjustment of its organism to its environment, but it has obviously no bearing whatever upon psychology. When it is said that the psychological function of the nervous system is to bring about the adjustment of the organism to its environment, it is evident therefore that this statement must be taken with some qualification, since we have no evidence to show that the increased growth of fur is due to any action of the nervous system. Manifestly we must draw a distinction between structural adjustments and functional adjustments, between adjustments of structure and adjustments of process —a distinction which corresponds with that drawn in a previous chapter between the redistributions of matter and of force that are effected by the organism. And since the redistribution of force is alone included in the function of the nervous system, it is evident that all structural adjustments may be placed on one side as outside the scope of its psychological function. The osseous framework by which the rigidity of the organism is adjusted to the force of gravity; the tough skin by which the resistance presented to the disintegrating force of friction is adjusted to the average intensity of the frictions met with; the alimentary structure which is adjusted to the kind of food habitually ingested: these and all other structural adjustments of the organism to its environment are outside the scope of psychological inquiry. Eliminating this class, there remain the functional adaptations,—that is to say, the processes by which the organism is adjusted to environmental conditions. Every process which takes place in the organism has, of course, some reference to environmental conditions, and normally every such process subserves in some way the adjustment of the organism to its environment; but still not all bodily processes are psychological facts. The movements of the intestines, the pulsations of the heart, the secretion of bile, are all processes which subserve the conservation of the organism,—that is, its adjustment to its environment; but they do not come within the domain of psychology. They are considered as strictly physiological, and in no sense psychological processes; and it is easy to see why. When we investigate these processes, we are investigating matters that lie within the boundaries of the organism itself, and immediate reference to the environment is absent. The process is looked upon as it affects the relations of the parts of the organism to one another—the movement of a part of the intestine with reference to its previous form, its relations to other parts, or to the abdominal wall; the movements of the heart with reference to the change of shape, capacity and volume that it undergoes, and to its relations with surrounding parts to its effect on the blood. The secretion of bile is looked on as an affair of blood, liver cells, bile ducts, and nervous influence; but none of these processes are regarded with direct reference to any circumstance in the environment. With psychological processes it is different. They may, it is true, be regarded only as bodily processes without reference to environmental condition, and this is their physiological aspect. But when they are viewed as psychological processes, the environmental conditions to which they are adjusted form an integral part of the concept, and cannot be taken from it without destroying its psychological character and significance. So long as we regard the alteration in the shape of the lens that is produced by contraction of the ciliary muscle, we are concerned with physiology only; so long as we investigate the mechanism by which an impression in the retina sets up a current which passes to a nerve-centre, and is retransmitted to the ciliary muscle, causing a contraction and a consequent alteration in the shape of the lens; so long we are attending solely to the processes in the organism without reference to environmental conditions, and we are in the domain of physiology. But directly we connect this nervo-muscular process in the organism with environmental conditions, and study the adaptation of the process to the distance of the object looked at, at that moment we enter the realm of psychology. The physiological function of the nervous system is to adjust the processes that occur in the organism to one another. Such adjustments take place when the movement of one part is made to follow or accompany the movement of another; when the supply of blood to a part is augmented in adaptation to its increased function; when the distention of a viscus is followed by movements of expulsion. But the psychological function of the nervous system is to adjust *the processes that occur within the organism to the conditions that exist outside of it.* Of course the two processes must occur together. The limbs cannot move in such a way as to carry the organism away from danger without at the same time moving with definite reference to each other. But the difference is sufficiently manifest between studying the mechanism of running, and studying the reasons for running away from a mad dog. When, therefore, it is said that the psychological function of the nervous system is to adjust the organism to its environment, what is meant is that the nervous system effects the adjustment of processes in the organism to circumstances in the environment; and that when these processes are looked upon not by themselves nor with reference to their harmony with one another, but with direct reference to the environmental circumstances with which they correspond, then we are dealing with the facts, not of physiology but of psychology. Something more, however, is implied in the psychological function of the nervous system beyond the adjustment of processes in the organism to environmental conditions. This function is not merely the adjustment of processes in the organism to environmental conditions; it is the adjustment by means of these processes of the *organism as a whole* to its environment. Physiology deals with *movements*. Psychology deals with *acts*. A part of the organism may move independently of other parts; but in an act the whole organism is concerned, and for every act the whole organism is responsible. Thus we arrive at a broad and deep division between the physiological and the psychological functions of the nervous system. The first is to adjust the internal processes of the organism to one another; the second is to adjust the organism as a whole to its environment. The difference between them is the difference between the functions of the judicial bench and those of the Foreign Office, or between those of the traffic manager of a railway and those of the board of directors, or between those of the staff of an hospital and those of the committee.

A group of movements combined together—co-ordinated—to effect a common end, constitute an act. Acts co-ordinated to effect a common end together constitute conduct. The co-ordination of acts, like the co-ordination of movements, is effected by the nervous system; and briefly, the study of the psychological function of the nervous system is the study of conduct. That dynamic adjustment of the organism to its environmental conditions, which we call conduct, is the outward manifestation of intelligence. The only criterion of intelligence is conduct, and by conduct alone can we judge of the amount or even the existence of intelligence in others. When we examine the qualities or factors in conduct which lead us to consider it as more or less intelligent, we find that there are four different standards or scales or criteria according to which intelligence in conduct is estimated.

Newton's proof of the identity of the force that draws the apple to the earth with the force that maintains the moon in her orbit, is a classical illustration of extremely high intelligence. In what consists its superlative ability? In the extreme *novelty* of the adjustment. The two cases of movement had never before been considered together; far less had they been brought under the operation of a single law. The operations necessary for the proof had never been dreamt of. The immense ability of the adjustment consisted in the vast difference between it and all previous adjustments. Had the thing been done before, and had Newton learnt it from others, far less ability would have been required for the task, and what ability there was would have been of a different kind.

A skilled organist performing a complicated piece of music on a high-class organ presents an example of the most conspicuous ability. Upon hearing, and still more upon seeing, one of these extraordinary displays, we are amazed at the amount of ability required and exhibited. The mere fingering of the proper keys at the proper times is a matter of some difficulty, requiring some intelligence and much practice for its accomplishment. Then this fingering has to be performed on one of three or more manuals, sometimes simultaneously on two or more, and the manuals have to be changed from time to time as the exigencies of the music require. At the same time the pedal clavier is in operation, and the feet are playing a part in the performance often very different from that of the hands. In addition to the clavier they have to manage the composition pedals and the swell. Then there is a multitude of stops and couplers, whose combinations are continually varying, and which have to be operated in exact accordance with the movements of the fingers on the keyboard, and with the exigencies of the music. The whole aggregate of operations being of such immense difficulty that but very few performers rise to the position of first-rate organists. Such persons are held to be of superior ability. They exhibit a high degree of intelligence. But the form of intelligence that they exhibit is evidently of a different order from that of the discoverer and the inventor. It consists not in the novelty, but in the *complexity* of their adjustments to circumstances.

Of two draughtsmen who are engaged on the same design, he is considered the cleverer whose lines follow with the greatest accuracy those of the model. There is here no question of originality nor of elaborateness in the adjustment. The superiority of the better draughtsman consists in his greater skill,—that is to say, in the greater *precision* with which his acts are adjusted to the end he has in view.

The fourth form of intelligence is that which is exhibited in the process called "getting on in life." The wealthy parvenu—the man who has forced his way to the front over heads of numberless rivals, the man whose business capacity has enabled him to make a fortune early in life—is said to exhibit superior ability. He is a man of unusual intelligence. Hundreds of his fellow-citizens entrust their money to the companies of which he is director, on the strength and in the belief that he is better able to carry out adjustments to circumstances than they are themselves. Yet his intelligence is not originality; nor is it exhibited in any great complexity in his operations. He discovers no new methods; he is not learned; his inability to acquire comparatively simple accomplishments renders him an object often of contempt to intellectual people. His intelligence, which is conspicuously great, is exhibited solely in *dealing with circumstances in such a way as to extract from them the maximum of benefit.*

I. Intelligence as manifested in the Novelty of the Adjustment.

It is very common to take reflex action as exhibiting the first dawn of intelligence; and reflex actions are commonly spoken of as examples of the simplest and most primitive rudiments of intelligent conduct. If by reflex actions are meant the actions of the lowest forms of organisms, then doubtless such a statement of their nature is correct. But in dealing with the human organism, the actions to which the term reflex is applied, while they exhibit the superficial resemblance to the reflex actions of primitive living beings of following at once and of necessity upon a stimulus, are in their fundamental nature profoundly different. As well might we call a bed of coal the rudiment of a forest, as call a reflex action in man a rudiment of intelligence. So far from being rudimentary, it is the very antithesis of a rudiment; it is *vestigial*. It exhibits, not the first, but the last stage of intelligent action. As the moon exhibits the settled changeless state towards which all the planets are tending; as the wood shows the rigid texture that each green shoot will at length assume; so the reflex act is the final stage at which every intelligent act at last arrives.

The first stage of intelligent action—the first rudiment of objective intelligence—is at the opposite pole to reflex action. It is seen when a new adjustment is made to outward circumstances; and the greater the difference between the new adjustment and previous adjustments, the more intelligent is the act considered—the more decisive is the evidence of intelligence. Mr. Romanes even makes the occurrence of a new adjustment the criterion of the existence of mind in the lower animals. "The criterion of mind," he says, "which I propose . . . is as follows:—Does the organism learn to make new adjustments, or to modify old ones, in accordance with the results of its own individual experience?" If this is true in animals, equally true is it that in man the most striking, the most pronounced, the most characteristic displays of intelligence are exhibited in discoveries and inventions,—that is to say, in new adjustments to circumstances; and the more unlike the invention or discovery to what has previously been known, the greater is the intelligence held to have been displayed. Whether in science, or in art, or in literature, or the processes of manufacture, or in the ordinary dealings of social life, the more originality a man evinces, the higher, other things being equal, is the estimate of his intelligence; and originality of adjustment means the formation of adjustments that are new, and that are widely unlike previous adjustments. If on the contrary he is an imitator, a plagiarist, an adaptor of other men's notions, he is considered less intelligent. In science those men are the most highly intellectual who make the widest generalisations, and who discover the most recondite facts. The greatest artist, in whatever region of art, is he who strikes out a wholly original course, who founds a new school. The inventive genius is he who devises the most novel means of overcoming mechanical difficulties. The witty man is the man who looks at things in new and unusual lights, who brings together ideas that have never been coupled before, and other things being equal, he is more witty the more incongruous the ideas he brings together, that is the more widely they have hitherto been separated—the more unlike his adjustment to previous adjustments. The dull man on the other hand is he who not only does not form new adjustments on his own account, but has a difficulty in following and assimilating them when suggested and shown to him by others. The more variety a man introduces into his life, the more novelties he introduces into his method of dealing with circumstances, the more ways he has of meeting difficulties, the more "resources" he possesses, the more vivid and active is his intelligence. On the contrary, the more he is the creature of habit, the more his acts of to-day resemble his acts of yesterday, the more monotonous and uniform his adjustments to circumstances, the less intelligence does his conduct exhibit.

A very common, and a very fully accepted test of a person's intelligence is the ease with which he acquires new accomplishments. Those who are quick in learning are considered more intelligent than those who are slow; and to learn a new accomplishment is to make a new set of adjustments to the environment.

In the experience of each individual the most intelligent acts are those which are in fundamental characters the most unlike those to which he is accustomed. An act of an altogether new kind, such as that required in learning some novel handicraft, requires and evinces more intelligence than an act that has often been performed before. Upon its second performance every act is more easily performed than when it was entirely novel, and with each repetition there is less of conscious exertion, of previous deliberation. As acts become habitual—as adjustments to circumstances lose their novelty—they at the same time lose their intellectual character. To find the way by map and compass through strange and difficult country evinces much more intelligence than to pursue the same route a second, third or fourth time; and when the same course has been followed for years, the intelligence involved sinks to a minimum. The origination of a new instrument, of an improvement in machinery, of the composition of a picture, is an act of high intellectuality; but to make replicas of the work evinces far less intelligence. Acts which have been performed so often as to be habitual, such as the operations of dressing, shaving, and most of the details in every handicraft—the formation of individual words in writing, the use of saw and hammer and file, and a hundred other instruments — are so little intelligent that while they are performed, the mind usually is engaged upon other subjects. By constant habitual repetition acts at length become *automatic*,—that is to say, they cease to have any special conscious accompaniment, and may be perfectly executed by an individual who is all the while carrying on totally different operations on a higher level of intelligence. The act of walking has reached the automatic stage. It has no special conscious accompaniment. We do not separately will each separate step. While we are walking, we can carry on animated conversations without paying any attention to the movements of our legs. The act of dealing a pack of cards becomes, with practised players, automatic. The mechanism by which it is carried on is so thoroughly organised that the dealer can perform complex operations of calculation during the time that his hands are executing with perfect precision the distribution of the cards. Lastly, an automatic act repeated continually in the lifetime of each of a long succession of generations becomes at length reflex. The nervous structure upon which it depends becomes so perfectly and completely organised that when the appropriate stimulus occurs, the act cannot fail to occur, and a reflex act is an act that has gone through the stages of intelligence, habit and automatism, and has become mechanical. When the bolus of food reaches the back of the throat, the act of swallowing follows of necessity, and this act is not intelligent. When an object suddenly approaches the eye, the lids close instantly and of necessity. The act is reflex, and it is not intelligent. A sudden noise close to the ear is followed by a start of the whole body. Again the act is reflex, and again it is not intelligent. Thus every act goes through a long process of organisation, which is here arbitrarily divided into four stages. The first time the act is performed it is an intelligent act, and it continues to be so for a length of time which varies with the complexity of the act, with the degree in which it differs from previous acts, and with the frequency with which it is repeated. Frequent repetition of an act extended over a considerable time renders it habitual; and an habitual act is much less intelligent than a novel act. The nervous mechanism by which it is performed has become so firmly organised that once the process is set going, it continues with but little stimulus from without the representative area. The area representing the act has become so far differentiated that it can act to a certain extent independently, and its action will continue without disturbance, even though neighbouring areas are in activity—even though the mind is occupied by other things. Long continued repetition renders an habitual act automatic. The stage of automatism is reached when an intelligent act can be carried on at the same time as the automatic act, without any the least interference with, or impairment of, the efficiency of the latter. Such is the case when a pianist converses while playing, when a bicyclist lights his pipe while riding, when a stocking-maker reads aloud while knitting. Lastly, the repetition of an act innumerable times during the life of many generations converts it at last into a reflex act—an act that is not only independent of intelligent acts, but which is organised with such completeness and depth, that when the appropriate stimulus is received, the execution of the act is a matter of imperious necessity. This is what is meant when it is said that a reflex act is an act not of rudimentary but of vestigial intelligence. It is an act that was once intelligent, that was once preceded by deliberation, by choice and by will, but that in the course of innumerable repetitions in the lifetime of many generations has become first habitual, then automatic, and finally reflex; and to this end all our acts are tending.

It is in the lowest strata of the nervous system that reflex acts are represented. Their mechanism constitutes a Laurentian formation that underlies every more recent deposit. On this foundation are laid layer upon layer of nervous arrangements, each higher stratum representing acts less deeply organised, from the paleozoic system of automatic acts, through the more modern and more superficial mesozoic period of habitual acts, up to the recent kainozoic formation of acts that are still intelligent. On the surface of all is a thin stratum, "the highest nervous centres," still mobile, still plastic—a stratum which is the seat of all the active change. Here are in course of formation those new arrangements of tissue which represent new adjustments to circumstances, which constitute the mechanism by which new acts are performed, and which, as fast as they are formed, are overlaid by and submerged beneath still more recent deposits.

II. Intelligence as manifested in the Elaborateness of the Adjustment.

The acts of a person who is learning to ride a bicycle constitute an entirely new adjustment to an entirely new set of circumstances. The acts of a skilled compositor setting up type may have passed through the habitual stage and become so completely automatic that the workman can converse on various subjects as he pursues his employment. Yet the acts of the compositor may be said, and said correctly, to be far more intelligent than those of the novice in bicycling. Evidently in such a case the term "intelligent" is not used as antithetical to reflex, but in a very different sense. It is used to characterise the degree of *elaborateness* of an act, quite apart from the stage of organisation which its mechanism has arrived at. The use of the term in this sense is more common than, and is as legitimate as, its use in the sense already expounded; but the two meanings are very widely different, and it is important to distinguish clearly between them. It is evident that when the term is used in the latter sense, regard is had not so much to the process occurring in the organism as to the circumstances in the environment to which the adjustment is made, and we may now shift our point of view, leaving the consideration of the process of adjustment which has hitherto occupied our attention, and taking up that of the forms and kinds of adjustment that the process brings about. Having considered the various stages of the process of adjustment as it occurs in the organism, we may now consider the various grades of circumstances in the environment to which the adjustment is made. While, however, the point of view is altered, and we look with more attention to the complimentary factor in the adjustment, it must not be forgotten that it is the adjustment as a whole with which we are concerned, and that the elaborateness, or complexity, or other characteristic of the circumstances in the environment that we have to consider, is of importance only as it indicates the elaborateness and the complexity of the adjustment of the organism to them.

Regarded from this point of view, and using the term "intelligent" to characterise not the novelty of the adjustment but its elaborateness, we find that acts are considered more and more intelligent according as they are adjusted to circumstances more and more distant in space; more and more separated in time; more special; more comprehensive;

more complex; and according to the number of minor adjustments that the act involves, includes and implies. All these qualities may be summed up in the term *elaborateness.* The exposition of the gradual rise of intelligence—of the gradual increase in the intelligent character of acts—as the grade of the adjustment rises along the lines indicated, is given in the most brilliant and masterly manner by Mr. Herbert Spencer in the chapters composing the "General Synthesis" in his *Principles of Psychology;* and those readers who are not acquainted with that work are strongly urged to study this portion of it at this stage. As Mr. Spencer's argument deals, not specially with the human organism, but with organisms in general, the doctrine as it applies to human organisms alone may be recapitulated here, but in view of the thoroughness of his exposition the recapitulation need be but brief.

Taking first the adjustments of the organism to circumstances distant in space, we find that other things being equal, the acts that refer to circumstances at greater distances are considered more intelligent than those that are adapted to circumstances less remote. The infant follows with his eyes a light that is waved in front of him, and cries when a stranger comes near, but to the light in the next room or the stranger a few paces off no answering act is adjusted. The daily acts of the child have reference to the circumstances immediately around him. He occupies himself with handling the objects within his reach, with observing through the window the passers-by, with play in the garden. But his horizon is limited. He can find his way from room to room, but not to a house in the next street. To circumstances as distant as that he cannot adjust his acts. The yokel whose experience is limited to his farm and his village is the accepted type of primitive intelligence in civilised man. Unable to picture to himself occurrences in distant places, he is necessarily unable to adjust his acts to them. To circumstances occurring in the outer world—to the political movements which agitate his compeers in the neighbouring town, to the cattle plague which has invaded an adjoining county—he makes no answering adjustment; they do not give rise to any modification in his conduct. By these circumstances the farmer who employs him must, however, be guided. To him it is of importance to know these things, and when we find that the occurrence of a great flood in a distant country may, by assuring him of a better market for a certain crop, induce him to devote a larger area of his land to that crop than he would otherwise have done, we see how much more extensive in space is the adjustment of the farmer's acts to his environmental conditions than is that of the labourer; and correspondingly the farmer's occupation is the more intelligent of the two.

The master of a fishing-smack, whose operations are limited to a few miles of water is not required to possess the attainments that are demanded of the commander of an ocean liner. The acts of the latter are adjusted to circumstances more distant in space; they require and they evince more intelligence. The work of the miner is less intelligent than that of the geologist. The former adapts his acts to the stratum of earth that lies immediately around him; while the acts of the latter may be adjusted to the outcrop of a stratum many miles distant, or to the disposition of a bed that lies thousands of feet beneath him. The operations of a village draper, who adapts his purchases to the requirements of local customers, are considered to evince less intelligence than those of the warehouseman who distributes his goods all over the country. To the obvious objection that the distance in space to which any adjustment is made is not always a criterion of the degree of intelligence displayed, as instanced by the superiority of the work of a microscopist or a mathematical instrument maker to that of a sportsman; the equally obvious answer is that the distance of the circumstance in space is not the *only* element that determines the degree of intelligence evinced, and that it is a criterion only when other things are equal—when the adjustments are in other respects so similar that the distance of the circumstance in space is a principal element in the difference between the two adjustments.

By the extension in Time of the adjustment of the organism to the environment is meant, not the duration of the act which constitutes the adjustment, nor the duration of any one circumstance to which the act is adjusted; but the duration of the *sequence of events* to which the adjustment is made. When a man dodges the stone that he sees coming at him, the act is adjusted to a very brief sequence of events, the duration movement of the stone being limited to a second or two. When he sees an angry man picking up a stone to throw at him and gets behind a tree to avoid the missile, his act is adjusted to an appreciably longer sequence of events—a sequence which includes picking up the stone and throwing it, as well as its flight—and the act is more intelligent. If he is told that a riotous mob is half a mile away, and is coming in his direction, and if he shuts his shutters to save his windows, the act is adjusted to a still longer sequence and is on a higher level of intelligence. These three acts are of the same general character and are adjusted to sequences of the same class. The first, which is adjusted to an extremely brief sequence, is little more than reflex. The second, which is adjusted to a slightly longer sequence, is little more than automatic; while the third, which is adjusted to a sequence (the approach, arrival and possible attack of the mob) which would take ten or fifteen minutes to complete, does not imply an exercise of very high intelligence, but it does denote some intelligence.

When we rise to the consideration of longer sequences, we find that if the acts are similar in other respects, the grade of intelligence that they are held to evince is proportionate to the length of the sequence of events to which they are adjusted. The act of the cook who puts the kettle on the fire ten minutes before tea-time is not considered equal in intelligence to that of the bell-founder who begins to heat his crucible eight hours before the time of casting. The acts are similar, but the one that is adjusted to the longer sequence is considered on that account the more intelligent. When I see a friend walking along a road parallel to the one I am in, and start on an oblique course so as to meet him at a point farther on, the act is more intelligent than that of catching a ball, which is adjusted to a shorter sequence, and it is less intelligent than that of travelling to Southampton to meet a ship which is due there from the Cape. Each prolongation of the sequence of events to which the acts are adjusted renders the conduct more intelligent. On all hands foresight is considered an indisputable proof of intelligence, and the degree of foresight shown is admitted as a reliable indication of the grade of intelligence reached; and extension of foresight means the adjustment of acts to events more and more distant in the future—to sequences that are more and more prolonged.

Nothing could be clearer or more forcible than Mr. Spencer's evidence on this head. "The lowest tribes of man," he says, "who wander from place to place as the varying supplies of wild animals, roots and insects dictate, do not adapt their conduct to periods exceeding a year in duration. Hardly worthy to be defined as creatures 'looking before and after,' their actions respond to few, if any, sequences longer than those of the conspicuous and often recurring phenomena of the seasons. But among semi-civilised races we see in the building of permanent huts, in the breeding and accumulation of cattle, in the storing of commodities, that longer sequences are recognised and measures taken to meet them. And when united in higher social states, men show by planting trees that will not bear fruit for a generation, by the elaborate educations they give their children, by building houses that will last for centuries, by insuring their lives, by struggling for future wealth or fame, that in them internal antecedents and consequents are habitually adjusted to external ones which are extremely long in their intervals. Especially is this extension of the correspondence in Time displayed by progressing science. Beginning with the sequences of day and night, men advance to the monthly changes of the moon, next to the sun's annual cycle, next to the cycle of the moon's eclipses and the periods of the planets; while modern astronomy determines the vast interval after which the Earth's axis will again point to the same place in the heavens, and the scarcely conceivable epoch after which planetary perturbations repeat themselves.

"When, as in these cases, the sequences exceed in length the lines of individual men, the correspondence is effected by the agency of many men whose actions are co-ordinated. An astronomer who computes the elements of a comet of brief period, and who after the lapse of certain years, months and days turns his telescope to that region of the heavens in which the expected body shortly makes its appearance, shows in himself the entire correspondence between an internal series of changes and an external series. But when centuries pass between the prediction and its fulfilment, we see that by the help of written symbols the proceedings of successive men are united into one long sequence, displaying the same adjustments to an external sequence as though it had occurred in a single man surviving throughout the interval. Perhaps nothing more strongly suggests the conception of an embodied Humanity than this ability of Humanity as a whole to respond to environing changes which are far too slow to be responded to by its component individuals."

The intelligence of an act increases with the *Speciality* of the adjustment—with the specific individuality of the circumstances to which the adjustment is made. Acts of low intelligence are acts that are equally adapted to the circumstances to which they are adjusted and to many others. As the intelligence of the act increases, so do the circumstances to which it is appropriate become more restricted; and acts of the highest intelligence are adapted to a combination of circumstances that is unique. Thus, to call out when you are hurt is an act of very low speciality—of very low intelligence. It is not only adapted to the particular occasion of a single wound, but is more or less appropriate to every possible occasion of being hurt, or of probability of being hurt. To call out for help is an act of greater speciality—of more intelligence. It is adapted only to those cases of injury which require assistance and occur in circumstances in which assistance is possible. To call out to a particular bystander to come and lift the beam that has fallen on your leg is manifestly an act adapted to the much more restricted circumstances of a specific accident, and it is one which is much more intelligent. To give him instructions how to make and fix a temporary splint on the leg that is broken is a still more intelligent act, and it is one that is adapted to the still more restricted circumstance of a specific injury resulting from the specific accident. The subsequent instructions as to making a splint of specific size and shape, with an interruption of specific length in a specific position, is adapted to the still more restricted circumstance of a fracture at a particular spot with a wound on a particular aspect of the limb.

Fly-fishing is a more intelligent recreation than bottom-fishing. Why? Because the worm is the food for many kinds of fish, and the bottom is the feeding-ground for many kinds of fish; and therefore fishing on the bottom with a worm is an adjustment to the habits of fish in general. But very few kinds of fish take flies on the surface, and commonly only one kind is so angled for at a time, and hence fly-fishing is an act adapted to a more restricted set of circumstances than bottom-fishing. The angler who selects his flies at random is a less intelligent fisherman than he who selects flies of particular forms and colours with special reference to the season of the year, the time of day, the locality and the weather; in short, he is the more intelligent angler who adjusts his acts to more specific sets of circumstances. The work of a navvy is extremely unintelligent; it is also of a very low grade of speciality. His operations with pick and shovel are equally well adapted to all the innumerable sets of circumstances for which earth has to be removed. Whether for making a railway cutting, excavating a dock, getting out the foundations of a house, sinking a well, opening a drain, digging for gravel, making bricks, or scores of other purposes, his conduct is equally appropriate. The determination of the precise amount of earth that has to be moved for any specific purpose, such as excavating the foundations of a house, and the specific extent and depth of the excavation, is a much more intelligent operation, and it is adapted to much more individualised circumstances—to the size and shape of the future building and the thickness of its walls. The individual acts of the navvy are equally devoid of specific application. They are equally applicable not only to many undertakings and to many places, but to many kinds of soil, and to many periods of time. The hours during which, and the speed with which he works, the space through which he moves each shovelful, are matters which do not affect the result. There is no need to adjust the acts to specific extents of space or specific moments of time. Compare such work with the work of the railway signalman. His eye must be for ever on the clock. Every movement must be performed at a specific moment of time. Every lever must be moved to a specific extent. Each act is adapted to far more restricted circumstances of time and space, and the conduct is far more intelligent.

"Agriculture," says Mr. Spencer, "as it develops, brings knowledge of the serial changes undergone by various plants and animals; while special materials, times, modes and places are adopted for the production of each. Improvements in the Arts have involved an incalculable multiplication of special processes adapted to produce special changes in special objects. Our whole social life, alike in the manufactory, in the shop, on the highway, in the kitchen, displays throughout the performance of particular actions towards particular things, in particular places at particular times.

"Above all, in exact science, or rather in the actions guided by exact science, civilisation presents us with a new and vast series of correspondences far exceeding in speciality those that came before them. For this which we call exact science is in reality *quantitative prevision,* as distinguished from that *qualitative prevision* constituting ordinary knowledge. The progress of intelligence has given the ability to say both that such and such things are related in coexistence or sequence, and that the relation between them involves such and such amounts of space, time, force, temperature, etc. It has become possible to predict, not simply that under given conditions two things will always be found together, but to predict how much of the one will be found with so much of the other. It has become possible to predict, not simply that this phenomenon will occur after that, but to predict the exact time at which it will occur, or the exact distance in space at which it will occur, or both. And manifestly this reduction of objective phenomena to definite measures gives to those subjective actions that correspond with them a degree of precision, a special fitness, greatly beyond that possessed by ordinary actions. There is an immense contrast in this respect between the astronomer, who on a certain day, hour and minute adjusts his instrument to watch an eclipse, and those of the farmer who so arranges his work that he may have hands enough for reaping some time in August or September. The chemist who calculates how many pounds of quicklime will be required to decompose and precipitate all the carbonate of lime, which the water in a given reservoir contains in a given percentage, exhibits an adjustment of inner to outer relations incomparably more specific than does the laundress who softens a tubful of hard water by a handful of soda. In their adaptations to external coexistences and sequences there is a wide difference between the proceedings of ancient besiegers, whose battering rams were indeterminate in their actions, and those of modern artillery officers who, by means of a specific quantity of powder consisting of specific ingredients, in specific proportions, placed in a tube at a specific inclination, send a bomb of specific weight into a specific object, and cause it to explode at a specific moment."

A game of chess is admittedly a more intelligent exercise than a game of draughts. If we seek the nature of the superiority of chess, we shall find it in the greater *complexity* of the game. All the draughtsmen have the same value and are moved in the same manner; but in chess each piece has a different value, and is moved in a different way. In other words, the circumstances to be met—the ways in which each piece can be attacked—are more numerous and more diverse; and the acts by which the circumstances are dealt with—the ways of moving the various pieces—are more numerous and more diverse.

The most striking and the most comprehensive of the ways in which an advance occurs in that form of intelligence with which we are now dealing, is the advance in the *complexity* of the adjustment of the organism to the environment. By the complexity of the adjustment is meant the *number and variety* of circumstances that are dealt with, and the *number and variety* of acts by which they are met. In other words, complexity increases as more numerous and more widely different circumstances are dealt with by more numerous and more widely different acts. As a general rule, the advance of the correspondence in complexity is at the same time an advance in the elements already dealt with —in Space, in Time, in Speciality, etc. Increase of complexity includes and implies, and is to some extent a measure of, advance in the other aspects of the correspondence.

The preparation of a piece of ground for planting by digging it over is an operation made up of very numerous acts, but the acts are very similar. It is a prolonged repetition of the same short series of acts. The number of different acts is very small, and the entire operation is one of great simplicity. If the ground is prepared by ploughing, the adjustment is more complex, for although it is still a repetition of very similar series of acts, yet the number of acts in each series is greater, and the difference between the several acts in each series is wider. In the one case the series consists only of plunging the spade into the earth, lifting and turning it. In the other, the series consists of the guidance of the plough both laterally and in depth, of the guidance of the horses, and of the turning at the headlands, each of which operations may require several acts. The series contains a greater number of acts; the several acts of which it is composed are more widely different from one another, and the whole series is repeated less frequently.

Not only are the acts more varied, but the intervals at which they are repeated are more varied. The several acts of inserting, raising and turning the spade, are repeated with monotonous iteration at approximately equal intervals of time; but the prevention of a horizontal swerve to left or right, the avoidance of too deep a dip, or of the coulter rising out of the ground, recur at intervals depending on the chance occurrence of stones or roots, or other differences in the nature of the ground—at intervals which are consequently very variable. Further, it is to be noted that the increase of complexity of the adjustment involves an extension of it in space, for while the spade labourer has in each stroke to attend to—to adjust his acts to—the square yard only within which he stands, the ploughman has to take into consideration in drawing each furrow, not only the ground covered by his implement and his team, not only the furrows already turned, but the undulations of the ground, the shape of the field, and the tree in the further hedge by which he guides his course. The more complex operation of ploughing is also a more special adjustment of acts to circumstances than the simpler operation of digging—it is adapted to a more restricted set of circumstances; for ground may be dug either for cultivation or for excavation, or for procuring mineral, but ploughing serves no purpose but that of cultivation. It is an advance in speciality of adjustment.

The operation of ploughing with the steam-plough is more complex than that of ploughing with the horse-plough. Regarded as a whole, the superior complexity of the operation is evidenced by the fact that the number and diversity of the acts that it requires is so great that it is no longer in the power of one nor even of two men to perform them all. The whole operation requires the management of two steam-engines, and of the plough which oscillates between them. It is unnecessary to point out how much more numerous and diverse are the acts required for the management of an engine than are required for the management of a team of cart-horses; but it may be remarked how this superior complexity of the operation includes extension of the adjustment of acts to circumstances in space, in time, and in speciality. Its extension in space is seen in the intimate dependence of the acts of each engineer upon the acts of his fellow at the opposite end of the field. Its extension in time is seen in the far longer sequences that have to be regarded in the operations of stoking the fire and filling the boiler; and its increase of speciality is seen in the more restricted circumstances to which it is adapted, for steam-ploughing is suited only to spacious fields and fairly level ground. As ploughing is a more intelligent operation than digging, so ploughing by steam is a more intelligent operation than ploughing by horse-power. To be able to dig no training and no practice are required. A ploughman has to learn his business; and a man must go through a course of instruction before he can manage a steam-plough.

The work of a clerk of the works is of more intelligent character than the work of the artisan under him, and the superior intelligence consists in the greater number and greater variety of the circumstances which he deals with, and in the greater number and variety of the acts by which he meets them. The navvy plies stroke after stroke, the hodman carries hod after hod, the bricklayer lays brick upon brick, each labourer goes through a narrow routine continually repeated,—a succession of similar acts adapted to similar circumstances. But the work of the foreman, in checking levels and plumb-lines, in adapting time and place of work of one man to that of another, in taking the time and testing the quality of work of his labourers, in getting proper quantities of materials to proper places at proper times, in giving directions for future operations, and comparing the work done with the plans, is a succession of many widely different acts adjusted to many widely different circumstances. The occupation of a master builder is more intelligent than that of his foreman, and again the superior intelligence consists in the greater number and greater variety of acts that are required to meet circumstances that are more numerous and more diverse. To the task of arranging the staff of men and the quantities and succession of materials required for one building is added the task of providing the same conditions for other buildings in other places. To the whole set of operations necessary for carrying out the actual construction of buildings is added the further set of operations necessary for providing the materials—the study of prices, of the fluctuation of the markets, of the comparative merits of different makers, negotiations with railway companies, etc. To these additional sets of operations are added the further set of operations required for obtaining orders—advertising, directly and indirectly, tendering for contracts, and all the subsidiary operations, calculations, etc., that tendering implies. Of still higher intelligence than the occupation of a builder is that of an architect, and still more complex is his adjustment of acts to circumstances. In addition to the knowledge which he, equally with the builder, must have of the details of excavating, of masonry, of bricklaying, of carpentering, of some parts of engineering, of plumbing, of smith's work, of plastering, of painting, of papering, of joinering, of tiling, and other artisan's work, of the resistance of various materials to various forms of stress, and of the prices of the various materials and work, there is a large number of conditions which he alone has to consider, and with which he alone has to deal. He has to consider the object for which a building is required, and to adapt its structure to that object. He must be aware of the several avocations and requirements of the people who are to inhabit the building, and to provide facilities and means for them. He must estimate the size and shape of the land at his disposal and plan the building accordingly. He must dispose his windows so as to gain a sufficiency of light for all parts of the interior. He must take care to obscure no ancient lights. He must harmonise the appearance of the exterior and the convenience of the interior. He must take into consideration the nature and inclination of the soil, the course of neighbouring drains, gas and water mains, etc. He must determine the materials that are appropriate for the building, and he must estimate the cost of every portion and of the whole.

If, instead of confining our attention to a single group of operations, we view each man's conduct as a whole, it will be found that the same criterion is applicable and is trustworthy. The labourer whose variety in life compares unfavourably in his own estimation with that of an "ass to a tinker," is regarded as leading a less intelligent life than the artisan, the artisan than the overlooker, the overlooker than the manufacturer, the manufacturer than the statesman. The man who rises in the morning only to hurry off to business, and who reaches home at night too late and too tired to do anything but dine and go to bed, leads a life which is less intelligent than that of one who is employed in the same business, but who has leisure, and spends that leisure in reading, in social amusements, in the cultivation of art, and in municipal and political work. And it is less intelligent because it is adapted to circumstances of fewer and less diverse kinds—because it is a less complex adjustment to the environment.

The degree of the complexity of the adjustment is itself a measure of intelligence, and it is roughly indicative of the extension of the adjustment in time, in space, and in speciality, as well as in the other features of advance—the co-ordination and integration of adjustments of which Mr. Spencer speaks. The whole of these features in the adjustment may be included under the single term of *elaborateness,* so that when we speak of the advance in the elaborateness of the adjustment of the organism to the environment, we mean an advance of the particular form of intelligence that has just been dealt with—an advance or extension of the adjustment in Space, or in Time, or in Speciality, or in Complexity, or in Generality, or in Co-ordination, or in Integration, or in some or all of these. It will be obvious that it is to elaborateness in the adjustment of the organism to the environment that the term intelligence is most usually applied. That this is not the only form of superiority in intelligence has already been shown, and other forms of this superiority have now to be noted.

III. Intelligence as manifested in Precision of Adjustment.

Quite distinct from the novelty and the elaborateness of the adjustment is its precision,—that is to say, the accuracy with which the act or operation is adapted to secure the end in view. One gardener, in raising a plant, may plan and carry out an elaborate system of heating, of ventilation, of moistening air and soil, of drainage; he may calculate to a nicety the ingredients necessary to introduce into the soil, he may devise a new manure, he may vary all the conditions of cultivation with the successive stages of the plant's growth, potting now lightly and now firmly, watering now much and now little, giving now a fine poor soil, later one that is rough and highly-manured, now sluicing with liquid manure and again drying off. In these numerous and varied operations he is carrying out a very elaborate adjustment of acts to the end in view, and so is exhibiting a high degree of intelligence. In so far as his devices are novel, he is displaying ingenuity or originality, and so also is exhibiting a high form of intelligence. But if, after all, he fails to bring his plant to maturity, he is considered less *skilful* than the working gardener, who contrives with a cucumber frame and a dung-heap to produce a handsome specimen. Even though the latter work entirely by rule of thumb, and carry out his operations by no more original light than the traditions received from his forefathers, his success entitles him to be regarded as superior in that form of intelligence which we term skill, and which, as will be apparent from this example, consists in *the precision of the adjustment of acts to ends.* Although the scientific gardener works by calculation, weighs and measures, regulates his temperature by the thermometer, and his atmospheric moisture by the wet and dry bulb, yet his failure demonstrates beyond all question that in spite of the elaborateness of the adjustment, it is wanting in accuracy—it is unskilful, and unskilful action is unintelligent action.

Similarly we may see an eminent mathematician, a learned historian, angling with all the paraphernalia that Oxford Street can furnish, and yet landing fewer fish than the village urchin, whose whole apparatus consists of a stick, a bit of string, and a bent pin. The complicated instruments of the professor require an elaborate series of acts to bring them into use, the intellectuality of his operations is unquestionable, but when all is done, the whole group of acts, far more elaborate though it be, is less accurately adapted to the end in view than those of the village lad. It is inferior in skill.

When a hole in the ground has to be filled and a dozen cart-loads of earth shot into it, the operation is one which does not admit of precision in the adjustment. It does not matter whether the earth is clay or gravel, or loam, or rubbish. A barrow-load, even a cart-load, more or less, will not make much difference. The work is one which does not require skill in the workmen, and the least intelligent class of workmen are employed for the purpose. When a tennis-ground or a bowling-green has to be levelled, it will not do to dump the earth down anywhere; it must be placed here or there. A barrowful put in the wrong place makes a perceptible difference. And every kind of earth will not do equally well. It must be good garden or pasture loam. For this work, in which greater precision in the adjustment is required, more intelligent workmen are employed, as is evidenced by the fact that higher wages have to be paid them. The operation of replacing a worn plank in the flooring of a room is a work of still greater precision. The new plank must not only be of a certain wood, but it must have special dimensions. It must be of just such length and breadth and thickness as to fill the hiatus, and yet no more than fill it. A difference of a quarter, of an eighth of an inch in the dimensions of the board makes here a serious difference. And the board must be placed in one particular position and no other. The acts of preparing and placing it have to be adapted much more precisely to the circumstances than in the previous cases, and the intelligence required is greater. When a damaged panel in a cabinet, or a fault in the surface of a billiard-table, has to be made good, the adjustment must be still more accurate. An irregularity no thicker than a sheet of paper will now seriously vitiate the result, and a more intelligent and more highly-paid workman is required for the task.

The whole difference between skilled and unskilled work is in the precision with which the acts are adapted to the ends in view. An unskilful draughtsman is one whose lines do not follow precisely their proper directions. An unskilful seamstress is one whose seams are not regular, are not precisely adapted to the end of maintaining an even fit. An unskilful writer is one whose writing is with difficulty read. An unskilful artisan is one whose work is clumsy or inefficient, and in either case is not precisely adjusted to the end in view. An unskilful man of business is he who makes less profit than a skilful one—whose buying and selling are less precisely adjusted to the fluctuations of the markets. An unskilful lawyer is one whose acts are not precisely adjusted to the end of serving his clients' welfare, and so of all other occupations.

Now note that to call a workman unskilful is reckoned equivalent to calling him stupid; and that in so far as a man is skilful in any occupation, in so far is he reckoned and called clever at that work. In other words, skill is universally considered to be a display of intelligence, and where other things are equal, it is considered a measure of intelligence. Doubtless the professor is considered a more intelligent man than the urchin who excels him in angling, but he is not considered so clever a fisherman,—that is to say, each is considered cleverest in that department in which he is most skilful—in those operations which are most precisely adjusted to compass the end in view.

IV. Intelligence as manifested in Conservation by Adjustment.

When we speak of the stupidity or foolishness of a man who neglects his business in order to go on the turf, we do not mean that he exhibits a want of intelligence in any of the senses in which the word has yet been used. In so far as he is forming new adjustments to new sets of circumstances with which he has never before been brought into contact, he is displaying not less but more intelligence than if he remained at home to carry on the routine of his shop or his bench. The circumstances that he now deals with may be more complex than those of his business. The different horses, their pedigrees, the characters and performances of their progenitors, their previous exploits, their training and condition, their fitness for this or that particular course, the reputation of their owners, the fluctuations of the odds, and the relations of his own bets to one another, may constitute a far more complex aggregate than the circumstances of his previous business; and his adjustment to these more complex circumstances, being more elaborate, will be more intelligent, than that which he displayed before. But we consider his conduct on the whole as foolish, because, in spite of the greater ingenuity and greater elaborateness of his new occupation we regard it as less likely to conduce to his ultimate welfare than that which he has discarded. We admit that he may be clever, but we say that he is wanting in prudence or common sense. If, however, he makes a *coup* in his new occupation, and, having gained a round sum, retires from the turf, the judgment is modified. He returns to circumstances of less novelty and less complexity; he has less scope for the exercise of ingenuity and cleverness; but his return is considered to evince more of this fourth form of intelligence which is called common sense than if he had pursued his sporting avocations. And it is so considered because it is judged more likely to conduce to his welfare. If he remains on the turf and loses his winnings, we regard our first judgment as confirmed; but if on the other hand he succeeds in making a fortune, the judgment is modified, and we now acknowledge that he pursued the most sensible course—the most intelligent course, by continuing his new occupation—we acknowledge that course by which the organism attains the most benefit to be the most intelligent. The clerk who plods to his office every morning, goes through his routine duties with the monotony of a horse in a mill, plods home at night, and continues the same monotonous round of simple duties day after day and year after year, does not display as much ingenuity or cleverness as the daring speculator who deals in a dozen different markets, in a score of different commodities, in several different countries; but if the former maintains himself and his family in comfort, and secures a provision for his old age, while the latter brings himself to ruin and terminates his career in the workhouse, we regard the conduct of the clerk as the most sensible of the two.

It is not merely ability to conduct business successfully that constitutes intelligence of this order, for if a man conducts his business capably and successfully, but squanders the income that he makes, or lives beyond it, he is considered less sensible, that is less intelligent, than if he were to live within his means and lay up something against a rainy day; and he is so considered because his conduct in the first case is not so well calculated as in the second case to secure the full benefit from his circumstances. By "benefit" is not necessarily meant mere pecuniary advantage. The term is used in a much wider sense as meaning everything which is advantageous to the organism, either directly by increasing its means of livelihood, or indirectly by diminishing the burdens, drawbacks and drains to which its means of livelihood are subject. Intelligence of this fourth form is manifested solely in what is called "the conduct of affairs," and according as his "affairs" are conducted successfully, or the reverse, according as such adjustments are made to circumstances as secure much or little benefit from them, intelligence is ranked as high or low. Indeed by this fourth standard intelligence is estimated with reference to the adaptation of conduct to the conservation of the organism; and is ranked higher the more thoroughly it subserves this end. This is the form of intelligence that is meant by "common sense," or shrewdness, and its importance is so great as to render further examination necessary.

It will be obvious that conduct which is so adjusted to circumstances as to secure from them the greatest benefit, must be conduct precisely adapted to secure this end; and hence this form of intelligence is, strictly speaking, included in the last; in other words, a high degree of common sense, or prudence, or shrewdness, is a high degree of skill of a special kind—of skill in conserving the organism. This special form of skill is, however, so important, and is, moreover, to so large an extent independent of other forms of skill in its development, that it is fully entitled to a separate consideration and to be regarded as a special form of intelligence equal in rank to the other three.

It is this fourth form of intelligence, this shrewdness or common sense, that is the distinguishing characteristic of the "practical" man, and its importance and value, actually great, are exaggerated by him into overweening supremacy. He regards it as the most important of all forms of intelligence; and he is right in so far as it is the form which is of primary necessity. Without shrewdness, ingenuity, cleverness, and skill are—not useless—but of little advantage to the individual. They are not useless, for although alone they will not ensure the survival of the individual in the struggle for life, yet they may enable him to achieve important results for the community or the race before he succumbs to adverse circumstances. And those who have great originality and skill with little shrewdness, are often disposed to value results obtained for the community or the race far above results gained for themselves alone.

The chief feature of shrewdness, and the feature which gives to it an irrefragable claim to rank co-ordinate with and to consideration separate from the forms already treated of, is this—that it is this form of intelligence whose disorder constitutes insanity.

However deficient a man may be in either of the other forms of intelligence, he is not considered insane unless this last form is defective; and when there is defect in this, he is allowed to be insane in however high a degree he may exhibit those other forms.

However lacking a man may be in originality, he is not called insane until the defect reaches so extreme a degree that he is unable to vary the daily details of his conduct in correspondence with the small daily novelties in the circumstances which surround him, until, in short, the want of originality vitally affects the conservation of the organism. He may be the merest animated cabbage, doing the same thing at the same hour every day in the year, moving between his bedroom and his porch in the summer, and between his bedroom and his fireside in the winter, but still he is not regarded as insane so long as he contrives so to modify his acts from day to day as to conform with the daily modifications in his environment. If, being old and bronchitic, he goes to his summer-seat in the porch when the snow is on the ground and the east wind is blowing, he is regarded as demented, and treated accordingly.

Similarly, unless a man is too stupid to get his own living, he is not regarded as imbecile; and proof that he is able to earn his living is a complete refutation of the charge of imbecility. In other words, however wanting in cleverness a man may be, he is not regarded as imbecile unless his adjustment to his environment is so wanting in elaborateness that it fails to include some circumstance that is necessary to his conservation. The more his earnings exceed his necessities—the more capacity he exhibits to gain advantage from his circumstances—the more complete is the answer to the charge of imbecility.

Neither is want of skill in any operation considered a proof of imbecility, unless it is of such a nature or of so extreme a degree as to interfere with the earning of livelihood.

It has already been shown that the occupation of a navvy, for instance, neither requires nor admits of the exercise of any save the most rudimentary skill in his work; and equally in his favourite recreation—skittles—accuracy in the adjustment of acts to ends is of the roughest and most primitive degree imaginable, yet he is not imbecile.

As deficiency of originality, or of cleverness, or of skill is not of itself regarded as proof of insanity, so neither is disorder or undue preponderance of either of these forms of intelligence accepted as proof.

The multitude of circle squarers, of discoverers of perpetual motion, and of geocentric fanatics, who vex the souls of righteous mathematicians, may be regarded as persons in whom the faculty of originality is disordered, or, more strictly, is out of proportion to their skill. They discover and rediscover ways, that to them are wholly novel, of solving these problems, but they are unable to appreciate that the problems are insoluble. They effect adjustments of considerable originality, but these adjustments are not accurately adapted to circumstances. They possess much ingenuity but little skill. Still, faulty and inaccurate as their adjustments are, no one would dream of calling such people insane, so long as their business was successfully conducted and their homes properly maintained—so long, that is to say, as they contrived to extract from their circumstances a due amount of benefit. But if they neglect their business to spend their time in arguing with obdurate scientists; if they spend on instruments and apparatus the money that should feed and clothe their children; if, in short, they exhibit a failure of the fourth form of intelligence, questions are immediately raised as to their sanity. And if, in their devotion to their theory, they lose their situations or bring themselves to bankruptcy, a jury would certainly decide that they were of unsound mind.

Similarly, disorder of that form of intelligence which is called cleverness is not of itself sufficient to constitute insanity. Were it so, every instance of forgetfulness would be evidence of dementia; every mistaken recollection a delusion; every erroneous act a mad one.

Neither is disorder of skill any evidence of insanity, or every mistake—every failure would be such evidence.

As on the one hand, defect and disorder of the three first forms of intelligence do not of themselves constitute insanity, so on the other insanity may coexist with a high degree of any of these forms of intelligence. A lunatic is not the less a lunatic because he is able to work out the binomial theorem, or to draw up the plans and specifications and oversee the work of building a church. Many idiots have had considerable skill in music, and some have possessed an exceptionally good power of calculation. Every asylum contains lunatics who are skilled workmen at some handicraft or other, and many contain as patients artists of no mean capacity. The possession of any or all of the three faculties of originality, cleverness and skill, is quite consistent with the existence of insanity. In spite of great ability, high intellectual attainments, and rare skill, a man is considered insane, not only by alienist, but by the general public and by the law itself, if he is "unable to manage his affairs;" in other words, if he is unable to extract from his circumstances a due amount of benefit for himself and those depending on him.

When we see a man in the pursuit of some chimerical object occupy all his spare time and money, we regard him as odd or eccentric, but we do not consider him insane. But if he becomes so absorbed in it as to devote his whole time and income to it, to the neglect of his family, friends and self, and brings himself to beggary, he is no longer considered of sound mind. Now suppose that after tasting the bitterness of poverty and degradation, after sacrificing everything—wealth, position, friends, wife, children, to his chimæra, he makes it a success. He takes out his patent; his device is adopted. Manufacturers compete for his services, wealth returns, friends return, wife and children are reinstated in their position. He becomes chairman of companies, enters Parliament, he is knighted —ennobled. Where are now those who said he was mad? They acknowledge their mistake. They were blind, foolish, misled. But if the man had been run over and killed when his discovery was complete, but before he had published or written it, they would have adhered to their opinion. He would still have been mad. Ought we then to blame the onlookers? By no means. Praise or blame would be alike inappropriate. But we must recognise that *their* *criterion of sanity was the success of the man in obtaining benefit from his circumstances.* So long as the balance was in his favour, the question of his sanity did not arise. When he began to decline in wealth, people began to whisper that he was "not right." When he came to dire poverty, every one thought him mad; and when he rose again to affluence, every one admitted the falseness of the imputation.

It is thus seen that the term *intelligence*, as applied to acts, or to the connected series of acts subserving a single end that we term an operation, or to the aggregate of operations that constitute conduct, is a term of wide and varied application, being commonly used, even in psychological writings, in at least four different senses; and it is scarcely necessary to insist on the importance of distinguishing which of these senses is attached to the term in any given case. These connotations of the term are, it is to be observed, entirely distinct from that which it bears when applied in subjective psychology, in which case it means the cognitive side of mind as distinguished from feeling. It has already been sufficiently remarked that the several forms of objective intelligence, as here distinguished, do not bear any constant or invariable ratio to each other, and it may serve to place the different forms in a clearer light, and to demarcate their distinctions, if we consider the different characters that result from their combination in various proportions.

The power of forming novel adjustments to circumstances must be possessed by all in some degree, since the circumstances of no two people are precisely alike; but the possession of a high degree of this faculty—the power of forming adjustments widely different from previous adjustments—is rare, and the combination of a high degree of this faculty with a high degree of elaborateness and accuracy is the highest and rarest of all intellectual gifts. It is this that constitutes *genius.* A genius is one who originates extremely novel ways of dealing with circumstances, and who adjusts these novel operations to the end in view with such accuracy as to ensure its attainment. A high endowment of originality without the complementary development of skill does not of itself constitute genius, as is evidenced by the circle squarers already spoken of. Nor does the most exquisite skill entitle a man to be called a genius if he displays no striking originality in applying it; as witness the Dutch school of painters, whose perfect technique, rarely equalled and never surpassed, was wasted upon themes beneath contempt, on depicting frowsy kitchen-maids and drunken boors. When a considerable degree of originality coexists with a marked deficiency in the precision of adjustments, the character so compounded is a somewhat peculiar one. The suggestion that canals should be cut with a uniform slope, so that barges should slide downhill from end to end without the aid of horse-power, marks an adjustment of extreme novelty to circumstances; but the failure to take account of the difficulty of keeping the higher portions of the canal full of water shows such a lack of precision in the adjustment as seriously detracts from the usefulness of the proposal. The same may be said of the proposal to ensure the safe custody of an article by locking it in a box and leaving the key inside. Persons who make adjustments thus combining considerable originality with little precision are not extremely rare. It would be convenient to limit to acts exhibiting these qualities the term "folly," which is commonly used in a somewhat less restricted sense to characterise acts that we do not approve. Persons who originate such imperfect adjustments form the glorious company of fools, using this term not as an abusive epithet but as a distinctive title. If it were used in this sense, the old saw that it takes a wise man to make a fool has a fresh significance, for the originality, which is a necessary feature in the character, is the basis of the highest of all forms of intelligence; and if we read the old saying as meaning that it takes a man of original mind to make a fool, we may accept it unreservedly. That there is a suspicion of misapplied originality latent in the term "folly" appears to be indicated by its application in many rustic neighbourhoods to innovations that appear useless. A house built in a new style of architecture, or a garden laid out in an unaccustomed way, loses its baptismal title, and is known only as So-and-so's folly. People who possess a good deal of originality, with but little skill, form the noble army of unappreciated geniuses. High originality and great precision in the adjustment of acts to ends in those matters in which the originality is displayed, by no means necessarily coexists with skill in extracting benefit from circumstances. The unthrifty reckless lives led by many men of genius are matters of common notoriety; but that there is no necessary antagonism between genius and shrewdness is shown by the existence of several cases, notably those of Rembrandt, Marlborough and Bacon, in which both have been highly developed.

Persons who are unable to form adjustments of a moderate degree of elaborateness are called *stupid*, and if the term is applied in this sense, the phrase, "a stupid fool," ceases to be a tautologous expression of dislike, and connotes two mental qualities which, though not contradictory, have a certain contrariety to each other. A person who is unable to originate novel adjustments to circumstances cannot be a fool, and is not necessarily stupid. To justify the application of the phrase in a descriptive sense, a person must have decided originality, with a low degree of skill and but little of what is ordinarily termed ability or cleverness. He must be unable to make elaborate adjustments. Those in whom an ability to form highly elaborate adjustments coexists, as it ordinarily does, with great accuracy of adjustment, form the large and increasing body of clever men. This class of character is peculiar in its steady advance as time goes on. Each generation of the human race contains a greater number of clever men, and the standard of ability is continually rising. The exceptionally clever man of the last generation would now find himself far from exceptional, and the exceptionally clever man of the present generation is far in advance of him. The other forms of intelligence, while they show some rise in standard and some more general diffusion, are far behind cleverness in their degree and rate of increase.

The highest form of genius is almost as rare as ever. Taking into consideration the enormous increase of population, it forms probably quite as small a percentage of persons born as ever it did. While ordinary ingenuity is undoubtedly the possession of a much larger number of persons than formerly, it is doubtful whether it has increased out of proportion to the population, and the same may be said of shrewdness.

A person in whom that form of intelligence, which consists in extracting due benefit from circumstances, is well developed, is called shrewd or astute; but there is no term to characterise those who are conspicuously deficient in this quality, though the term *unthrifty* comes nearest to doing so. As has already been said, this form of intelligence is very independent in its development, and may accompany a very high degree or a very low degree of the other forms.

Between the several characters composed as above described there is very apt to occur a mutual aversion and contempt. One congratulates himself that he is not a money-grubbing Philistine, another thanks God that he is neither a theoretical fool nor a brilliant unpractical will-o'-the-wisp.

CHAPTER VIII

THE NERVOUS MECHANISM OF CONDUCT

The adjustment of the organism to the environment is effected by movements resulting from nervous processes, and the nerve-regions in which these processes take place must, it is clear, represent the entire organism; for if they represented a part only, then this part alone would be adjusted to environmental conditions. It has already been shown that the region of the organism represented in a nervous centre becomes more and more extended, the higher the centre is situated in the hierarchy, and hence we are prepared for the conclusion that in the highest centres of all the whole organism is represented. The problem now before us is this: What is the process in these highest nervous centres by which the acts of the organism are adjusted to external circumstances? We have already seen the mechanism by which acts are effected. The additional factor that we have to consider is their appropriateness to the circumstances in which they occur. Such adaptation of acts to circumstances can only be brought about by an influence—a moulding and modifying influence—exercised by the circumstances on the organism. So that there is action and reaction. Action of the environment on the organism, and reaction of the organism on the environment; and the character of the action determines the character of the reaction. The question is: How is this reaction suitably modified by the character of the action? Clearly an impress on the organs of sense is transmitted to the highest nervous centres, and so modifies their action that the resulting movements are appropriate to the impressing circumstances. It is the character of this process that we have to investigate.

Suppose that a man is travelling along a narrow lane in the dark and in a strange country. Presently he is brought up by a hedge blocking the way in front of him. He turns to the left with outstretched hands, and in a couple of paces he plunges them into a quickset hedge. Now he faces about and finds that the lane turns sharp to the right, and that in that direction there is an unobstructed road.

In this case there is a novel adjustment of the organism to novel circumstances. The man had never travelled that lane before. When he came to the turning-point, it became necessary to originate a course of conduct applicable to the new circumstances. What is the process? An adjustment is made—an act is performed—which has in past experience been found generally suitable in circumstances generally similar. Although the traveller has never been along that particular lane, he has often been along roads, streets and passages in which direct progress was obstructed, and a deviation has been made. Hence the course that he now pursues is a deviation to one side and not a climbing over or a turning back. His first deviation is at once met by an obstruction, and is followed by an injury—by the pricking and scratching of the quickset. Now, the effect of injury on the organism is to lower the intensity of its vitality, or, in other words, to depress and weaken the intensity of the nervous discharge throughout the whole organism. Hence any action that is going on when injury is received is by the injury diminished in energy, and hence the contact of the quickset tends to stop progress in that direction. This tendency is reinforced by the habit produced by innumerable experiences in the course of innumerable generations, all of which have gone to educate the organism into arresting a movement that is at once followed by injury. Progress toward the quickset at once, therefore, ceases. The attempted adjustment to the new circumstances has failed, and a new one must be sought. This time the traveller turns to the right, and in this direction his way is unobstructed. Now the giving way, or surmounting or turning of an obstruction, is at once followed by an increase in the general intensity of the nervous discharge. The form becomes more erect, the eye opens wider, the features brighten. At the same time this general augmentation of the nervous discharge produces accelerated progress in the direction now found unobstructed.

Such is the way in which a new adjustment is made to circumstances—the method of trial and error. The process in the nervous system that accompanies and actuates this adjustment is as follows:—On arrival at the obstruction the impression made by the whole situation on the organs of sense travels to the highest nervous regions. Arrived here it permeates those channels and arouses those activities that have been similarly excited by similar previous experiences. By hypothesis no previous experience has been precisely similar, but many have had characters in common,—that is to say, no obstruction has been met with in precisely similar circumstances, but many obstructions have been met with in circumstances somewhat similar. Hence the activities aroused are those generally suitable to all cases of obstruction,—that is to say, activities tending towards surmounting, turning and retirement. Between these activities there is a momentary struggle for preponderance, but since in previous experiences of obstruction, those obstructions that most resembled the present have been overcome by turning, the preponderance is at once gained by the activities directed towards turning, and those directed towards surmounting and retreat sink into quiescence. So far the course to be pursued has been determined by previous similar actions in previous similar circumstances, but we have now arrived at the differentia between this and all previous experiences. No previous experience indicates whether, in the case supposed, the turning should be to the right or to the left. It is at this point that the novelty of the adjustment begins. What is the process? Activities are aroused tending to produce a turning to right and turning to left. The turning to the left is determined, it may be, by an impression from without—by an appearance of less obscurity in that direction, or by an inclination of the ground assisting effort in that way. The contact with the quickset hedge, causing injury to the organism, at once depresses all activities, and tends of itself to check progress in that direction. This tendency is at once corroborated and reinforced by the bias fixed by innumerable previous experiences which have shown that persistence in a course that is followed by injury increases the injury. So that for innumerable generations in the life of the race there has grown up a tendency for injury to arouse a powerful inhibition, which arrests the activity preceding the injury. So that in the present case the turning to the left is arrested, and the activity directed towards turning to right at once rises into undisputed preponderance. The turning to right is effected, and the obstruction is obviated. At once occurs a vivification and reinforcement of the nervous discharge; and this vivification, while on the one hand it is general throughout the nervous system, as shown in the increased tonicity and energy manifested throughout the whole body, on the other hand is most intense in the regions most concerned, in which it produces special effects. From the regions aroused by the impress of the whole circumstances on the organism, to the regions whose activity produces the turning to the right, there occurs a rush of discharge, which clears between them a channel of communication that always remains pervious; so that whenever the one region is aroused into activity, a gush of discharge at once flows to and arouses the activity of the other. The consequence is, that whenever the organism is again impressed by the same circumstances, that is, again proceeds down that lane and meets that obstruction, the activity of turning to the right is instantly evoked, and the right course is taken without hesitation or mistake.

Here is the explanation of an occurrence, which in the last few pages has been taken for granted *ad interim*, viz., that a given set of circumstances arouses by its impress on the organism the same reaction that it has previously aroused.

This consequent reaction occurs by virtue of the channel of communication formed between the region aroused into activity by the impress of the circumstances and the region whose activity produces the reaction. And this channel of communication is formed by the gush of discharge that accompanies an act that is successful. Hence it is by a strictly physiological law that successful acts tend to be repeated, and that unsuccessful acts tend to be suppressed.

By hypothesis there has been no previous experience precisely similar to the present experience, but by hypothesis there have been many previous experiences (of obstruction), which have had much in common with the present experience. The impressions made by the present circumstances on the organs of sense may, therefore, be divided into those that are common to the present and other circumstances, which are by far the more numerous, and those that are peculiar to the present occasion. Both groups of impressions set up combinations of nerve-currents, which pass directly by the most permeable route to the highest nerve-regions. For the first group the most permeable route will of course be the route that has been previously travelled by previous similar impressions, and this route will conduct it to a receiving region of gray matter which has previously received and been modified by innumerable similar currents. This region has, under similar provocation, discharged many times before in several directions, each discharge passing to a motor region representing some form of bodily activity. The paths leading to those regions whose activity was in previous cases unsuccessful will have been seldom traversed, and will be but slightly permeable. The paths leading to regions whose activity was in previous cases successful will have been often traversed, and will be freely permeable. Hence it is into the latter paths that the discharge of the receiving regions will in the present case most freely flow, and it is thus that the activities of turning are provoked. Turning to right and turning to left having been in the long run about equally successful, and therefore equally frequent in previous cases, there will be no spontaneous tendency for the one activity to preponderate over the other. Turning to left is determined by an *impression* (of less obscurity) in that direction, for this impression is common to the present and innumerable previous cases in which this impression has been followed by progress towards it, which has been successful, and has therefore been repeated. Here again it is the portion of the impression common to this and previous experiences which determines the nature of the activity that is evoked. Again, when this activity brings the hands into contact with the quickset, it is the *impression* (injury of tissue) common to this and innumerable previous impressions that instantly evokes the *activity* (withdrawal) that has always in past experience been evoked by similar impressions and been successful. Thus at this stage also the action taken is determined by previous experience. Lastly, the turning to left having failed, turning to right is adopted as the *habitual* alternative—the alternative commonly adopted in the past.

Thus we see that a novel adjustment to new circumstances is in reality a repetition of previous adjustments to so much of the new circumstances as is common to the new and the previous experiences, and that to so much of the circumstances as is completely novel, the adjustment that is made is that which has succeeded in circumstances that appear on the whole most similar. In other words, there is no such thing as circumstances absolutely novel, but only new combinations of old circumstances; and similarly there is no absolutely new adjustment to circumstances, but only new combinations of ways of dealing with circumstances. These new combinations of actions are represented in the nervous system by new combinations between centres or regions representing the actions. And the combination of movements in determinate ratio, or their co-ordination, is effected, as we have seen, by the growth of new centres superposed on and communicating with the centres representing the movements that have to be co-ordinated.

If this is so, in what consists the originality of an adjustment? It consists in the nature of the factors in the new circumstances which arouse the activities. Let us take a case. Here are two cattle-breeders who find that their stocks are not fattening as fast as is desirable. This is a circumstance that has often occurred before, and in the first breeder it arouses the habitual reaction—the administration of more food. The circumstance to be met is the inadequate proportion between assimilation and waste, and the factor in the circumstance that arouses this course of conduct is the deficient assimilation, which is met by the administration of more food. But in the second breeder the factor that arouses activity is the excessive waste, and he deals with this case as he has dealt with other cases in which material has diminished owing to excess in the proportion of waste over addition. He recognises that the waste is due to undue loss of heat owing to ruinous and draughty houses, and instead of increasing food he builds his cattle better quarters. This is a more original way of meeting the circumstances than the previous way, and it is so because the factor that arouses the activity is a factor of more comprehensive and fundamental importance. While the first man looked merely to the factor of amount of food, the second looked at the question as a matter of proportion between food and waste. The activities aroused in the first case were those simple activities represented by previous experiences, that a thing increases when it is added to; but the activities in the second case were the more complex and fundamental and uncommon and accurate activities that are represented by the experiences that a thing increases only when more is added to than is taken from it. The way of meeting the circumstance is a new way when adapted to that particular circumstance, though it is old as adapted to other and simpler cases. The novelty of the adjustment consists in applying to a new and superficially different circumstance, a course of action found successful in circumstances fundamentally similar.

Once this reaction has been aroused by this set of circumstances, the change in the nervous system will be such that not only will in future the same activity be aroused with greater readiness and certainty by the same and very similar circumstances, but there will be an increased tendency for the same factor to arouse activities when combined with circumstances widely different. For instance, if the desideratum is to obtain, not a fat beast, but a vigorous young apple-tree, the course of conduct will be moulded on the same lines, and will be directed not only to supplying abundant nutriment in the shape of manure, but to cutting off opportunities for unprofitable expenditure of nutriment, by pinching off the fruit-buds during the first year or two.

An original course of conduct or an original adjustment to circumstances is not therefore an entirely novel action; it is the adaptation of an old way of meeting circumstances to circumstances different from those usually so met. Now it has been explained that in the presence of novel circumstances, or what is for our purpose the same thing, of old circumstances in which new factors are prominent, the process in the nervous system is the arousal in a nascent condition of all the ways in which circumstances apparently similar have previously been met. Among all the nascent activities thus aroused there is a struggle for preponderance, and that finally gains the mastery and passes into action which has previously been found most successful in dealing with circumstances most similar. It is obvious, therefore, that the more numerous the activities thus aroused, the more possibilities will there be for such action as we call original, and the number of the activities aroused will depend, in part on the number of resemblances perceived between factors in the present circumstances and factors in previous circumstances, and in part on the readiness with which diffusion of activity takes place in the highest nervous regions.

For originality of conduct it is necessary, then, that a large number of activities should be aroused by the impress of circumstances. Other things being equal, the struggle for preponderance among a large number of activities should be of longer duration than the conflict of a smaller number. Until this conflict is decided, and one activity gains the mastery and passes from the nascent state into actuality, there can be no movement of the organism—no action. Hence we should expect to find that an original course of conduct is preceded by more *hesitation* than an habitual course of conduct; and this is confirmed by experience.

It has been seen that the whole physical foundation of intelligent action is the effect which the passage of a current of nervous discharge has in clearing a channel between two nerve-regions. When an activity follows an impression, it is because a current has been set up from the nerve-region in which the impression is received to the nerve-region which represents the activity. If this particular activity has never before followed this particular impression, there is no established channel between the two for the current to follow. The draught of nervous energy penetrates the ground substance of the gray matter or passes by circuitous routes from the one region to the other. But as it passes, it scours out a channel, so that on the next occasion that the impression is received, the discharge follows more readily the same route to the same destination. And each successive discharge of the region receiving the impression passes with greater facility than the previous discharges, and by its passage renders it an easier matter for the next discharge to pass to the region representing the activity.

Thus is laid the structural foundation for the passage of new acts into habitual acts. The new act is performed with hesitation, which is the interval that elapses while the conflict between the various nascent activities is going on. The habitual act is performed without hesitation, for now that there is a definite and restricted channel of communication between the two nerve-regions concerned, there is no diffusion of discharge on its route, and consequently no arousing of other activities, no conflict and no hesitation. With the continued and repeated recurrence of the sequence between the impression and the act, the nerve-regions that represent them become connected by an organised process so complete and so readily evoked that the energising of the one brings about the energising of the other with mechanical accuracy and regularity. The arrangement is however not so completely fixed but that it can be interfered with, modified and prevented by discharges from other and especially from higher regions. This is the structural condition that underlies automatic acts. When the process has been repeated so many times in the life, not only of the individual but of the race, that the organisation of the structure is complete and fixed; and when, moreover, the process has been so little varied that all side channels admitting the varying currents have been built out, then the energising of the one centre is instantly followed by the energising of the other without variation and without possibility of interruption or delay. The process has now reached the stage of reflex action.

It is evident that the elaborateness of the adjustment of the organism to the environment will depend on the elaborateness of the constitution of the higher nervous centres. The ability to meet a large number of different impressions by a large number of different acts must depend on the ability to discriminate between the various impressions and to initiate the various acts. And each separately discriminated impression, like each separate act, requires a separate combination of nerve-elements. So that elaborateness of adjustment must depend on elaborateness of nervous constitution.

The precision with which acts are adjusted to ends, similarly depends on the accuracy with which nice shades of difference between impressions are discriminated, and on the definite limitation of the acts by which the circumstances are dealt with, and on the appropriateness of the one to the other. The first two qualities will depend on the definiteness with which various combinations of nerve-elements are demarcated from one another, and the last will depend on the influence of experience as already set forth. And the definiteness of demarcation of nerve-combinations will depend on the readiness with which channels can be scooped, and cells separated out of the ground substance of the gray matter.

PART III

MIND

CHAPTER IX

THE CONSTITUTION OF MIND

THE subject-matter of the studies upon which we are now about to enter is profoundly and fundamentally different from that of every other study that can engage the human mind. Every other department of human knowledge deals with things in the world outside of us, or with relations between such things. Subjective psychology deals with the states and processes of our own minds. So long as we are dealing with intelligence as objectively manifested—with acts and their adaptation to circumstances,—so long we are dealing with movements of matter, we are pursuing a branch of knowledge of the same kind as that which deals with the movements of planets round the sun or the movements of molecules in heated iron. But we have now to take an entirely different view. We have to turn our attention from the universe around us to the universe within, and to investigate facts of an order so totally different from any hitherto dealt with, that by no effort are we able to imagine a community of nature or similarity between the two. "While under its objective aspect," says Mr. Spencer, "psychology is to be classed as one of the concrete sciences which successively decrease in scope as they increase in speciality; under its subjective aspect, psychology is a totally unique science, independent of, and antithetically opposed to, all other sciences whatever. The thoughts and feelings which constitute a consciousness, and are absolutely inaccessible to any but the possessor of that consciousness, form an existence which has no place among the existence with which the rest of the sciences deal. Though accumulated observations and experiments have led us by a very indirect series of inferences to the belief that mind and nervous action are the subjective and objective aspects of the same thing, we remain utterly incapable of seeing, and even of imagining, how the two are related. Mind still continues to us a something without any kinship to other things; and from the science which discovers by introspection the laws of this something, there is no passage by transitorial steps to the sciences which discover the laws of these other things."

I do not propose here to enter on an exhaustive analysis of mind. Without implying that a thorough acquaintance with such analysis is unimportant to alienists, for whom this work is primarily intended, it may be omitted here for two reasons: first, because it has been admirably done by many previous writers; and, second, because, while all introspective psychology is important to the alienist, some portions of the science are of special and urgent importance, and these are the very portions which have not hitherto been brought into a condition adapted to his needs. To these portions, therefore, his attention will be mainly directed.

A topic even so isolated as that of subjective psychology admits of being regarded from more than one point of view; and according to the aspect on which it is considered, the treatment of it may conveniently be divided. States of consciousness may be viewed from a purely introspective standpoint, and with reference solely to their comparison with one another; as, this feeling is more pleasurable than that, or that is more vivid or more voluminous than this; or such a judgment is more complex than such an other, or such a thought is of unusual novelty. This way of viewing states of consciousness takes account formally and directly of nothing but the states of consciousness themselves. The view is confined to the interior of the mind itself and does not explicitly refer to anything beyond its limits. Another way of viewing states of consciousness is to regard them in connection with the environmental circumstances with which they correspond. When so regarded the aspect is of course not entirely introspective, but yet it still pertains to subjective psychology, insomuch as what we are examining with reference to its correspondence with environmental circumstances, is no longer a phase of conduct or a nervous process, but a state of consciousness. It is this latter division of subjective psychology that the alienist is chiefly concerned with, and it is with this that we shall mainly deal. A feeling may be regarded as a state of consciousness and compared with other feelings. Such a view is wholly introspective. But it may also be regarded as a state of consciousness corresponding with the action upon the organism of an agent in the environment. The view is now no longer wholly introspective, but it still pertains to the domain of subjective psychology, for it deals with the correspondence to environmental circumstances, not of conduct nor of nervous processes, but of mental states. The subject-matter of the inquiry is no longer limited to matter and movement; it is mainly and principally concerned with consciousness. Similarly, a thought may be regarded as a relation between feelings — a purely introspective view. But it may also be regarded as a relation between feelings corresponding with a relation between circumstances in the environment. When so regarded, the thought is still a mental fact, and its consideration still pertains to subjective psychology, but it is no longer viewed wholly introspectively. It is viewed from a different standpoint—in a new relation.

Taking first the purely introspective view, states of consciousness are divisible into two orders. The division here adopted is Mr. Spencer's, and cannot be put so well before the reader as in his own words (*Principles of Psychology*, vol. i. p. 163): "The proximate constituents of Mind are of two broadly-contrasted kinds—Feelings and Relations between Feelings. Among members of each group there exist multitudinous unlikenesses, many of which are extremely strong; but such unlikenesses are small compared with those which distinguish members of the one group from members of the other. Let us, in the first place, consider what are the characters which all Feelings have in common, and what are the characters which all Relations between feelings have in common.

"Each feeling, as we here define it, is any portion of consciousness which occupies a place sufficiently large to give it a perceivable individuality; which has its individuality marked off from adjacent portions of consciousness by qualitative contrasts; and which, when introspectively contemplated, appears to be homogeneous. These are the essentials. Obviously, if under introspection, a state of consciousness is decomposable into unlike parts that exist either simultaneously or successively, it is not one feeling, but two or more. Obviously, if it is indistinguishable from an adjacent portion of consciousness, it forms one with that portion—is not an individual feeling but part of one. And obviously, if it does not occupy in consciousness an appreciable area, or an appreciable duration, it cannot be known as a feeling.

"A relation between feelings is, on the contrary, characterising by occupying no appreciable part of consciousness. Take away the terms it unites, and it disappears along with them; having no independent place, no individuality of its own. It is true that under an ultimate analysis, what we call a relation proves to be itself a kind of feeling—the momentary feeling accompanying the transition from one conspicuous feeling to an adjacent conspicuous feeling. And it is true that notwithstanding its extreme brevity, its qualitative character is appreciable; for relations are (as we shall hereafter see) distinguishable from one another only by the unlikenesses of the feelings which accompany the momentary transitions. But the contrast between these relational feelings and what we ordinarily call feelings is so strong that we must class them apart. Their extreme brevity, their small variety, and their dependence on the terms they unite, differentiate them in an unmistakable way."

From the introspective standpoint, the feeling and the relation between two adjacent feelings are the only elements of which consciousness is composed. These are the elements into which every state of consciousness, however complex, however voluminous, however elaborate, can be resolved. And this is not all that this exposition of the structure of mind teaches. It teaches also that plan upon which these elements are built up to form those more elaborate and complex states. Take the states of consciousness aroused by striking the notes of a musical instrument. A single note arouses a single feeling—a feeling of sound. A note followed by another note arouses three conscious states. There is first a feeling of sound, then a feeling of another sound; and in addition to these two feelings there is consciousness of the relation between them, as of equality or difference of pitch or loudness. This relation between the two feelings is obviously much more unlike either of the feelings than the feelings are unlike each other. So long as consciousness is occupied with this or that sound, there is feeling pure and simple; but directly we become aware that this sound is louder than that, or that is shriller than this, we are forming a *judgment*. Consciousness is no longer occupied exclusively with feeling. The attitude of feeling has passed into the attitude of thought. Neither the feeling nor the thought can, it is evident, exist in the absence of the other. A sound continued indefinitely without break or variation ceases to be heard—the feeling when not limited by a relation ceases to be a feeling. A relation, it is obvious, cannot exist apart from its limiting terms. But while neither can exist in total isolation, the two are never equally prominent in consciousness. The varying condition of consciousness in which first the one element and then the other rises into superiority, may be represented by F r F, followed by f R f. Now if the two notes are struck simultaneously, a new state of consciousness arises, differing from each of the three previous states. It is a state compounded of the two previous feelings, *and of the relation between them*. When a note with its third or fifth are struck simultaneously, we are aware of two sounds, and of a difference in pitch between them. Yet the three states of consciousness are blended into a single state so completely that we speak of a chord of music as a single sound. The three states have become consolidated into one. And now note that this new state thus composed is a feeling; a compound feeling it is true, but still a feeling; and being a feeling it may enter as a unit into the composition of a new relation. Suppose that one chord is followed by another. Then, precisely as in the case of a single note followed by another, there is a feeling, followed by a feeling and separated by a relation, and, as in the previous case, either the feelings or the relation may chiefly occupy the consciousness—may be the prominent component of the conscious state. If the sound of the first chord is represented by $(F\,r\,F)$ and the sound of the second by $(F'\,r'\,F')$, then the state of consciousness constituting the cognition of a similarity or difference in loudness, or pitch of the two compound sounds would be represented by $(F\,r\,F)\,R\,(F'\,r'\,F')$.

But these are not the only relations that can be established between the two chords. Consciousness may be occupied with the similarity or difference of the interval between the first pair of notes to the interval between the second pair. The interval between the first pair may be a third, and the interval between the second pair a fifth; and consciousness may be occupied with the relation between these two intervals. But each of these intervals is itself a relation between the pitch of one note and the pitch of another. In this case, therefore, consciousness is occupied with a relation between relations, which may be represented by the symbol $C = (f\,R\,f)\,R\,(f'\,R'\,f')$.

We may imagine each of the terms of this relation to be composed of the feelings aroused by chords of three or more notes, each additional note adding to the complexity of the feeling aroused by the chord into which it enters; each more complex chord adding to the complexity of the relation of which it forms a term; and each more complex relation consolidated into a feeling, adding to the complexity of the relation of higher order of which, when so consolidated, it forms a term. When to differences of pitch, interval and number of simultaneous sounds are added differences in the succession of sounds; the relations, the feelings that they form, and the higher and higher orders of relations into which they become combined, reach a very high degree of complexity; and when to these differences are added differences of timbre by the employment of different instruments, the complexity of relations—that is to say, of thoughts—is still further increased. Yet even if the relation which occupies consciousness is the comparison of one opera with another, each being executed by a full orchestra, and each consisting of innumerable parts, and occupying two or three hours in its performance, it is easy to see that the judgment arrived at as to their merits is precisely the same in form as the judgment of the superiority of harmony of one chord to another. In the one case as in the other the content of consciousness is a relation between two terms. In the one case the terms are of extreme simplicity, in the other they are of extreme complexity, but the judgment still consists in the establishment of a relation between them. What is true of feelings of sound is of course true of all other kinds of feelings, and of combinations of these kinds of feelings with the feelings of sound and with one another.

It is necessary to warn the reader against supposing that such dissertations as the foregoing have only a speculative and philosophical interest. They have also a practical bearing of great moment. If the account just given is correct—if feelings of high complexity and thoughts of high complexity are each of them composed of multitudes of both feelings and thoughts of simpler character—then feeling cannot be disordered without disorder of intelligence, neither can intelligence be disordered without feeling being disordered likewise. If the constitution of mind be such as is here described, then not only must those older authorities be in error who looked upon the existence of a delusion as the sole evidence, criterion and test of insanity, but those more modern writers who imply by the terms Moral and Emotional insanity that feeling can be disordered independently of intelligence, must also be mistaken.

Mr. Spencer has already dealt with this subject (*Principles of Psychology*, §§ 64, 210, 211, etc.), but its importance is so great that it will be advisable to enforce and emphasise it by a more extended treatment.

"If all mental phenomena," says Mr. Spencer, "are incidents of the correspondence between the organism and its environment; and if this correspondence passes insensibly from its lowest to its highest forms; then we may be certain, *à priori*, that no orders of Feelings can be completely disentangled from other phenomena of consciousness. . . .

"Before proceeding to the synthetic interpretation it may be well to remark that, even in our ordinary experiences, the impossibility of dissociating the psychical states classed as intellectual from those seemingly most unlike psychical states classed as emotional, may be discerned. While we continue to compare such extreme forms of the two as an inference and a fit of anger, we may fancy that they are entirely distinct. But if we examine intermediate modes of consciousness, we shall quickly find some that are both cognitive and emotive. Take the state of mind produced by seeing a beautiful statue. Primarily, this is a co-ordination of the visual impressions which the statue gives, resulting in a consciousness of what they mean; and this we call a purely intellectual act. But usually this act cannot be performed without some pleasurable feeling of the emotional order. Should it be said that this emotion arises from the many ideas associated with the human form, the rejoinder is, that though these aid in its production, it cannot be altogether so accounted for, seeing that we feel a kindred pleasure on contemplating a fine building. If it be urged that, even in this case, collateral states of consciousness are induced which suffice to explain the emotion, then whence results the gratification given on looking at a simple curve, an ellipse or parabola? The manifest difficulty in disentangling the cognitive from the emotive in these cases becomes in other cases an impossibility. Not only does the state of consciousness produced by a melody show us cognition and emotion inextricably entangled, but the state of consciousness produced by a single beautiful tone does so. Not only is a combination of colours, as in a landscape, productive of a pleasurable feeling beyond that due to mere sensations, but there is pleasure accompanying the perception of even one colour when of great purity or brilliance. Nay, the touch of a perfectly smooth or soft surface causes an agreeable consciousness. In all these cases the simple distinct feeling, directly aroused by the outer agent, is joined with some compound vague feeling indirectly aroused.

"Otherwise put, the matter stands thus. The materials dealt with in every cognitive process are either sensations or representations of them. These sensations, and by implication the representations of them, are habitually in some degree agreeable or disagreeable. Hence, only in those rare cases in which both its terms and its remote associations are absolutely indifferent, can an act of cognition be *absolutely* free from emotion. Conversely, as every emotion involves the presentation or representation of objects and actions, and as the perceptions, and by implication the recollections, of objects and actions, all imply cognitions, it follows that no emotion can be *absolutely* free from cognition.

"The relation between intelligence and feeling will be most clearly understood on studying the relation between perception and sensation, which are the simplest forms of the two.

"Every sensation, to be known as one, must be perceived; and must so be in one respect a perception. Every perception must be made up of combined sensations, and must so be in one respect sensational. But though they have the same essential elements, these elements are not similarly dominant in the two. In sensation, consciousness is occupied with certain affections of the organism. In perception, consciousness is occupied with the relations among those affections. Sensations are primary undecomposable states of consciousness, while perceptions are secondary decomposable states, consisting of changes from one primary state to another. Hence, as continuance of the primary states is inconsistent with the occurrence of changes, it follows that consciousness of the changes is in antagonism with consciousness of the states between which they occur. So that perception and sensation are, as it were, ever tending to exclude each other, but never succeeding. Indeed, consciousness continues only in virtue of this conflict. Without the primary affections of consciousness there can be no changes from one primary affection to another; and without changes from one to another there can be no primary affections, since in the absence of changes consciousness ceases. Neither consciousness of the changes, nor of the affections between which they occur, can exist by itself. Nevertheless, either may so predominate as greatly to subordinate the other. When the changes are so rapid that the states forming their antecedents and consequences do not last for appreciable times, consciousness is almost wholly occupied with changes—with the relations among sensations; sensations are present so far only as is needful for the establishment of relations among them, and we have that condition of consciousness called perception. On the other hand, when the states forming the antecedents and consequents of the changes have considerable persistence, or rather when they are not permanently destroyed by the changes but continually return, and are thus broken by the changes only so far as is needful to maintain consciousness—when, therefore, some one of them, by its continued recurrence, greatly predominates over others, then there results the condition of consciousness called sensation."

Mr. Spencer then goes on to show that what is true in these lowest regions of Mind, in which consciousness is occupied with simple sensations and perceptions, is equally true in the higher and highest regions, in which the subject of consciousness is the complex combination of many of these simpler states, and he concludes by stating that "cognition and feeling throughout all phases of their evolution are at once antithetical and inseparable."

While fully agreeing with Mr. Spencer's general conclusion that cognition and feeling are inseparable portions of one process, I think that his statement requires an addition and a modification before it can be accepted as expressing the whole of the relationship between them. Distinct in their elementary forms, at least to the extent that feeling can exist almost wholly apart from cognition, and cognition can be easily distinguished from feeling, as the development of Mind rises higher and higher, feeling comes to contain more and more cognitive elements, cognition includes more and more of the elements of feeling, the two become more and more intimately blended, until in the highest phases of Intelligence they are absolutely inextricable, and that which is in one aspect a cognition is in another aspect a feeling.

Viewed subjectively, feeling is a state of consciousness having an appreciable duration, or in Mr. Spencer's words, "a portion of consciousness which occupies a place sufficiently large to give it a perceivable individuality, which has its individuality marked off from adjacent portions of consciousness by qualitative contrasts, and which, when introspectively contemplated, appears to be homogeneous." "A relation between feelings is, on the contrary, characterised by occupying no appreciable part of consciousness. Take away the terms it unites (or separates) and it disappears along with them, having no independent place, no individuality of its own. It is true that, under an ultimate analysis, what we call a relation proves to be itself a kind of feeling —the momentary feeling accompanying the transition from one conspicuous feeling to an adjacent conspicuous feeling," etc. While feelings of the elementary nature above described are the elements from which all Feeling is compounded, so relations between the feelings are the elements of which all Cognition is built up. It is evident from the foregoing that the cognitive element of Mind is the change from one state of consciousness to another; and change is appreciable in proportion to its suddenness. The more sudden the change from one state of consciousness to another the more strongly characterised is the relation between them,—that is, the more prominent becomes the cognitive element. Where feelings are not definitely demarcated from one another, but one glides into the next by insensible gradations, there the cognitive element sinks into insignificance. On the other hand, when feeling is sharply limited, it must be by the juxtaposition of another feeling, and the change from one feeling to the next,—that is, the prominence of the cognitive element, is great in proportion to the sharpness of the limitation between the feelings. The suddenness of the change, although a very important factor, is not, however, the only factor which determines its conspicuousness. It is evident that if two feelings are both of them insignificant, however sudden may be the change from one to the other, the relation between them cannot be a conspicuous one. The difference between a white paper and one having a very faint shade of yellow may not be apparent at all unless the two are viewed in rapid alternation; and the more rapidly the one is substituted for the other, the more likely is it that the difference will be recognised,—that is to say, the more conspicuous becomes the cognitive element. But this is not all. If both the papers are very small, a difference may remain unrecognised which will become apparent when larger areas are seen,—that is to say, the conspicuousness of the cognition bears a direct relation to that of the feelings between which it subsists. For a conspicuous change to occur, one at least of the feelings that bound it must be of considerable magnitude. Here, then, there is a direct relation between the prominence or intensity of thought and that of the accompanying feeling.

It may also be shown that the complexity of feeling has a direct relation to the complexity of thought. "In the development of Mind," says Mr. Spencer, "there is a progressive consolidation of states of consciousness. States of consciousness once separate become indissociable. Other states that were originally united with difficulty grow so coherent as to follow one another without effort. And thus there arise large aggregations of states, answering to complex external things—animals, men, buildings—which are so welded together as to be practically single states. But this integration, by uniting a large number of related sensations into one state, does not destroy them. Though subordinated, as parts of a whole, they still exist; and being severally in their original forms *feelings*, this state, which is composed of them, is a *feeling*—a feeling produced by the fusion of a number of minor feelings. Hence a certain pleasure accompanying all kinds of perceptions, as every child shows us. Not only does this hold with groups of simple sensations that are united to form perceptions, but it holds with groups of these groups." The more evolved feelings are, then, built up of aggregations of simpler feelings, but, it should be observed, not of feelings alone. A state of consciousness which is composed of many states that have become coherent, although it may serve in consciousness as a unit, and enter as a whole into further combinations, although, in short, it is consolidated, is yet not homogeneous. The compound molecules, ammonia and cyanogen, are practically single radicals. They exist in the free state and enter into combinations as units, but they are not homogeneous. Their component atoms may easily be cleft asunder and reappear in their separate state. When this is the case it is obvious that the atoms cannot have been incorporated together by mutual fusion or solution as one drop of mercury unites with another, or syrup unites with water. Although they are for the time bound up together, they must still retain their individuality. And if this is so—if the component atoms in a molecule retain, as we know they do retain, their individuality—then it is obvious that they must bear a certain relation to one another—they must be disposed in some sort of arrangement. It is the same with a compound feeling. It is made up of simpler feelings, but these feelings although combined are not fused. It bears on its surface, as it were, the intersecting lines which mark out the separate component feelings by whose union it has been formed. It is made up of states of consciousness indeed, but of states having a certain arrangement—of states bearing certain relations to each other,—that is to say, it is made up of a group of feelings *and of the relations between them*—it is a compound group of feelings and cognitions consolidated into a unit—it is a compound radical. Thus the more highly developed feelings contain as an integral part of their constitution both feelings of a lower order and relations between them—both feelings and cognitions. And the more highly evolved the compound feeling, the more numerous are the simple feelings that compose it; and the more numerous the components, the more numerous must necessarily be the total number of relations in the group, supposing these relations to be as simple in the higher feelings as they are in the lower. But they will not be equally simple. A highly complex feeling is composed not of simple feelings directly aggregated together, but of feelings that are already compound in a less degree. It is not a group of simple feelings, but a group of groups. Such an arrangement must, it is obvious, contain many more relations than a mere aggregate of simple feelings,—that is to say, the more complex the feeling, the greater the number of cognitions that it contains. Again, as the simple feelings that go to make up a complex feeling become more numerous, relations which are, as it were, their dividing lines must be not only more numerous also, but must in their aggregate bear a greater proportion to the whole. And if these simple feelings are already grouped in minor combinations before their incorporation into the more complex feeling, then the dividing lines of the groups must be added to those of the individual feelings, and must still further increase the proportion which the aggregate of relations bears to the aggregate of feelings.

That the character of a compound feeling depends as much upon the mode of arrangement of the constituent feelings as upon their nature, admits, I think, of *a posteriori* proof. The group of presentative-representative feelings which go to make up the concept of a handsomely marked cobra di capello may be compounded into the feeling of Fear, or into the feeling of Beauty, and of both of these feelings several shades of difference may exist. The component elementary feelings are the same in each case, and the difference in the resultant compound feeling can be due only to differences in their arrangement. A familiar illustration from the physical world will help to render the matter clear. Two atoms of carbon with four of hydrogen and one of oxygen, if combined so that the carbon is in direct union with both oxygen and hydrogen, forms aldehyde— $\begin{array}{l} C\equiv H_3 \\ \;| \\ O=C-H \end{array}$. The same numbers of the same elements, if combined so that the oxygen unites directly with the hydrogen alone, forms ethylene oxide—$\left.\begin{array}{l} C-H_2 \\ C-H_2 \end{array}\right\} O$—a very different body. To complete the parallel it should be said that aldehyde itself undergoes minor rearrangements, by which, without alteration of its chemical composition, its physical characters are considerably modified.

When feeling reaches its highest development, the number of its component states becomes so great, and their connections so intricate, that the relations between the various component feelings and groups of feelings rise into co-ordinate importance with these states themselves, and occupy in the aggregate as large an area of consciousness. When this degree of complexity is reached, the feeling may as justly be considered to be compounded of cognitions as to be compounded of sensations. Such a feeling is that of Power, which is the outcome of a number of experiences of successful efforts, and which may as justly be considered to result from the aggregate of cognitions of successful efforts as from the aggregate of feelings that accompany them.

Just as, in the development of Feeling, cognition becomes a more important and more integral constituent as the grade of feeling becomes higher; so in the development of Intelligence, feeling gradually rises from a position of subordinate importance in the lowest grades of cognition to a position of co-ordinate prominence in the highest.

Since relations between feelings are themselves feelings, though of momentary duration—since, that is to say, the main difference between feelings and relations is a difference of duration—it follows that, if from any cause the transition from one primary feeling to the next is prolonged, the relation will approach in character the feelings between which it subsists; and if the transition be considerably prolonged, the relation may attain, in addition to its relational character, a character as feeling indistinguishable from theirs. It is easy to show that such a prolongation must occur, as the terms between which the relation subsists become more complex—that is, as thought becomes more developed. The change from one simple state of consciousness to another simple state—from one sound for instance to another, or from one colour to another—can be effected with such rapidity as to be virtually instantaneous, and the feeling accompanying the change from the one state of mind to the other is a feeling of change only—a pure cognition. But it is different when the change is from a complex group of sensations and cognitions to another such complex group. When one term of the relation is the group of sensations and cognitions which goes to make up the consciousness of a cobra di capello in a certain position, and having a certain freedom of access, and the other term is the group which makes up the consciousness of the deadly effects of its bite, it results that not only does each component term occupy a larger field of consciousness, but that the change from the one term to the other can no longer be effected with the instantaneous rapidity of the former case. Of the various component states and relations of the antecedent group some will be more persistent than others—will disappear from consciousness more slowly—will linger in consciousness slightly longer than others. Similarly of the term to which the change is made, some elements will be more conspicuous—will sooner arrest attention—will slightly precede the rest in consciousness. In other words, the change from the antecedent state or group of states of consciousness to the consequent state or group, will occupy time. And a state of consciousness which occupies an appreciable period of time is a feeling. Furthermore, not only is the antecedent state of consciousness as a whole brought into relation with the consequent state as a whole, but when the states are compound, some of the several parts of the one are brought separately into relation with some of the parts of the other. It is impossible, for instance, to think of the cobra biting except as using his teeth, nor is it possible to think of being bitten without some localisation of the part bitten as here or there. Now since consciousness is a serial succession, these several minor relations cannot be established simultaneously. They must pass through consciousness successively, and the succession, however rapid, must occupy some time. There are therefore two conditions which tend to prolong the duration of the higher forms of cognition, and thereby to give to these cognitions an additional character as feeling; and the higher the development of the cognition, the more pronounced must this tendency become. When at last we reach concepts of a very high degree of complexity, the feeling that accompanies them attains a position of co-ordinate importance, and is often confused with them; and when at last we reach concepts of a very high order, the cognition and the feeling are scarcely separable even on careful introspective analysis.

Having shown from the subjective side that cognition and feeling must become more inextricably blended the more highly each of them is developed, let us now turn to the objective aspect and show that they do become so.

Feelings, we find, which have no definite limitation either in time or space—which, therefore, arise and fade gradually and without sudden change—are attended with the least accompaniment of cognition. Such a feeling arises on the gradual transition from a cooler to a warmer air. With a developed intelligence the feeling is cognised as due to a change in the environment, but the feeling is the same in kind and degree whether it is attended by the cognition of the external agency, or whether it occupies consciousness merely as pleasurable feeling without any such cognitive accompaniment. Doubtless, the feeling, to be pleasurable, must be perceived in the colloquial sense of the term, but scientifically, perception is a case of the correspondence of inner with outer relations, and in the case supposed there is no such correspondence, and therefore no true perception. A fish enveloped by a warmer stratum of water will experience an analogous feeling, but no one will contend that the fish cognises the increased temperature of the water as the agent which arouses the feeling. In such a case as this the feeling arises and subsides gradually—has no definite limitation in time; and affects all parts of the surface of the body alike—has no definite limitation in space. It therefore presents the minimum of conditions for cognition, and the cognitive element of mind is present in insignificant amount. Nevertheless this element is not wholly wanting; for since the medium directly affects the surface only, there will arise some contrast, however vague, between the feeling it arouses, and the feelings initiated in other parts of the organism, and from this difference will result some vague perception of "outness" which will be the sole representative of the cognitive side of mind.

When we rise from feelings thus vaguely determined to feelings determined by agents that have definite limitations either in Time only, as the feelings of sound, or in both Time and space, as the feelings of touch and sight, we pass at once from feelings in which cognition is absent to feelings of which cognition forms an inseparable accompaniment. Feelings, such as those of sound, which are limited in Time only, are those with which the least intellectual element is associated, and from which such intellectual element as there is can be with least difficulty dissociated. Sound is the state of consciousness which corresponds with and is aroused by the action of an aerial vibration in the environment. A melodious tone gradually arising and gradually dying away, arouses a pleasurable feeling which may appear to be almost destitute of cognitive elements, but it will be admitted that it is impossible to experience such a feeling without some more or less definite concept of its mode or place of origin being formed; or if this be denied, which I think it cannot justly be, yet it is certain that such a feeling is referred to some agency external to the organism—is thought to be produced by an object, and this objectifying of the cause is a process of cognition. The exclamation, What's that! which is elicited by a sound suddenly produced—that is to say, sharply limited in Time—illustrates by its almost instantaneous occurrence the intimate union that exists between the feeling of sound and the cognition which refers it to an external agent. With feelings of touch, including, together with touch proper, such feelings as pressure and tickling, the cognitive element is more conspicuous, since none of them can be appreciated without some consciousness of the part of the body in which they originate, which implies a consciousness of special relations, which is a process of cognition; and when we rise to the sense of sight, the blending of cognition with feeling becomes so intimate that the two are with difficulty separable. It is impossible to have an idea of a colour except as occupying some position, more or less definite, and as covering some area more or less vaguely limited; and it is equally impossible to think of an area, a line, or even a point, except as of some colour. To many the statement that the representation in consciousness of a point is impossible except in association with some colour, will appear unfounded, but this arises, I believe, from all points being thought of from a natural association with printed diagrams, and print as black—an inconspicuous colour. If mathematical diagrams were commonly printed in red ink, and if stray motes of dust were scarlet instead of black, it would be difficult for us to think of a point otherwise than as a red speck.

Hence it appears that into feelings of all but the very lowest grades, some element of cognition enters as an inseparable associate; but although always associated with feeling in experience, the cognitive element can be separated by introspective analysis, and feeling still retain its character as feeling. Although it is impossible to think of any particular colour as existing apart from surface, yet it is quite possible to have such a preponderating consciousness of one or the other that we may be said to think of colour or surface without attending to surface or colour. They are separable in analysis to the extent that we can, as in the case of geometry, deal with surface as if colour were now existent, and as in the mixing of pigments, we may have such a preponderant consciousness of colour that surface is almost forgotten. Although cognition accompanies the feeling, it plays such a subordinate *rôle* that it is unnoticed until attention is specially called to it. Furthermore, and this is the most important aspect of the relation between them, the feeling and the cognition are virtually simultaneous in their origin. The cognition of surface, though consciously or sub-consciously it is always present with the feeling of colour, does not precede the feeling.

With the next class of feelings cognition rises to a position of greater prominence, and becomes not only an integral constituent of the feeling, but even an antecedent necessity. The occurrence of the feeling depends on the previous formation of the cognition. Take away the cognition and the feeling vanishes. Take, for instance, the feeling of Fear. Fear is that state which is aroused by a certain relation to the organism of a certain class of agents —by the accessibility of the organism to noxious agents of superior power. In this, as in every other case in which a feeling is aroused, not by the action of an agent upon the organism, but by the specialised relation which the agent bears to the organism, it is evident that before the feeling can be experienced the relation must be cognised. An unperceived relation is nothing. It may exist, but if it is not known, there can be no corresponding feeling. Take a concrete case. A man feels no fear on meeting a small dog in the street unless he knows or suspects—cognises more or less certainly—that the dog is rabid. Only when this cognition is effected does the feeling come into existence. Again, a man who views out of a high window a rabid dog chained in the yard below feels no fear. Horror he may feel, but not fear; and why not? Because the relation of accessibility of himself to the dog is not only absent, but is cognised as absent. If the man were in the yard with the dog, however securely the dog might be chained, yet if the man did not know that he was secure, he would still feel fear. Similarly, if he thought the dog was mad he would be afraid, even though it was actually healthy. Hence, for fear to be felt, a double process of cognition is a necessary antecedent. The agent must be cognised as noxious, and the relation between the organism and the agent must be cognised as one of accessibility. If either of these cognitions fail, the feeling is absent; and if both of them are present, the feeling will arise even if one or both of them are erroneous. Fear will arise in the presence of a harmless agent if it is cognised as noxious, and in the presence of a noxious agent which cannot gain access to the organism if it is believed that it can; and Fear will not arise even in the presence of a deadly agent, which has free access to the organism, so long as it is believed to be innoxious or inaccessible.[1] In the feeling of Fear, therefore, as compared with the feeling of Colour, not only is there a much larger proportion of cognitive element in the total state of consciousness, but this element occupies a much more prominent position, and is more intimately mingled with the feeling.

After what has been said, especially at the opening of this chapter, it will not be necessary to show by further concrete instances how much larger a proportion of feeling enters into the constitution of cognitions of higher grade than into those of lower grade. It will be enough to call to mind that when cognitions become highly developed, they acquire so pronounced a character as feeling that they actually receive the titles of feelings. The feelings of Belief, Doubt, Perplexity, Conviction, and several others are on their reverse side cognitions, and may correctly be regarded either as cognitions or as feelings according as we view them on the reverse or the obverse.

If the position here defended is a correct one, and if feeling and thought are indeed always associated, and become more and more inextricably blended, the higher the level to which they attain; if feelings of the higher grades are largely made up of cognitions, and cognitions of high grade partake largely of the nature of feeling, then it must be impossible for either feeling or thought to suffer

[1] There are other cognitions antecedent to the feeling of Fear, but the foregoing are sufficient for the purposes of the illustration.

disorder without the complementary element of mind suffering disorder also. The answer of the practical man may be anticipated. " It is all very well," he will say, " for you to tell me that delusions can't exist without disorder of feeling, and that moral insanity can't exist without disorder of the intellect; but I know as a fact that they *do* exist alone, and facts are proverbially stubborn. Here is a case of the one and there is a case of the other, and you can't argue them out of existence." Certainly not. What is here contended for is that more exists in these cases than the practical man recognises. As feeling and thought are different factors of consciousness—as the same elementary constituents may compose a feeling or a thought according as the one or the other attains preponderance—it cannot be denied that a disorder may weigh with preponderating stress upon the one element or upon the other. What is denied is that the disorder can be limited solely to either. The answer to the practical man's assertion that he can adduce cases of the independent disorder of feeling or of thought, is that a thorough investigation directed to this end would have brought out evidence of disorder of the other factor of consciousness; and he may be, and hereby is, challenged to produce one case so investigated in which such evidence was wholly absent.

Reference has been made in a previous chapter to the representation of a movement in a nervous centre, and this use of the term representation was then fully expanded. The same term is used in an entirely different sense in subjective psychology, as must now be explained. On introspective examination states of consciousness are found to be divisible into two great classes according as they are vivid or faint. When I see a mass of green, I have a feeling of the vivid order. When I shut my eyes and think of the green, I have a feeling of the faint order. When I hear a sound, I have a feeling of the vivid order; when I think of it during silence, I have a feeling of the faint order. When I perceive a cow, the percept belongs to the vivid states; when I think of the cow, the thought belongs to the faint states. In every case the vivid state of consciousness is referred to the actual presence, at the time it is felt, of an object in the environment, which presents certain qualities for appreciation. Hence all vivid feelings directly evoked by objects presented to the senses are termed presentative feelings. Thus all presentative feelings are vivid; but presentative feelings often drag along with them into consciousness other feelings which are intimately bound up with them, and which, though not actually presentative, attain a vividness almost equal to that of presentative feelings, and hence some vivid feelings are not presentative. When I have a faint feeling, when pale image of a vivid feeling arises in consciousness, those qualities which before were presented to my senses are now said to be represented in consciousness, and the feeling or the percept is a representative one. When many objects, all having the same quality, have been presented to my senses, and when in their absence there arises a consciousness not of this or that object possessing the quality, but of the quality as abstracted from the objects presenting it, it is obvious that this state of consciousness involves the repetition or re-arousal in a faint form of many presentative states, —that is, it involves the occurrence of many representative states. From each of these grouped states of consciousness a single state is, as it were, selected, and represented over again; and the state thus re-represented is termed a re-representative feeling. Each successive step in abstractness of thought is thus a step in the representativeness of thought.

CHAPTER X

THOUGHT

THOUGHT or cognition may, as has been said, be regarded from two aspects. It may be regarded as the process of establishing a relation between feelings or clusters of related feelings; or it may be regarded as the process of establishing relations in the organism in correspondence with relations in the environment. And similarly cognitions or thoughts, which are the states resulting from the process of cognition or thought, may be regarded either as relations between simple or compound feelings, or as relations in the organism corresponding with relations in the environment. When I think that my remembrance of last night's conversation is more vivid than my remembrance of a conversation of a month ago, I am dealing with the relation between one state of consciousness and another state, between one remembrance and another remembrance; but so long as I do not take account of the correctness of my reminiscences, so long I am taking a view that is wholly introspective, and am disregarding the correspondence of my mental states with the environmental conditions to which they refer. When, however, I ask myself whether my statement was correct that the currents round the north pole of a solenoid go in the direction of the earth's revolution, I am taking a view that is no longer wholly introspective. I am now asking whether the relation in my mind (the concept of the direction of this revolution is similar to the concept of the direction of that) is in correspondence with the relation in the environment (the direction of this revolution is the same as the direction of that). To put the two cases in graphic form may render this important distinction still clearer.

Mental State.	Relation.	Mental State.
This reminiscence	is more vivid than	that reminiscence.

Nothing in the terms of the above relation is outside the limits of consciousness.

	Organismal Term.	Relation.	Environmental Term.
Mental state	This concept	corresponds with	This direction (of a revolution in the environment)
Relation	is similar to		is similar to
Mental state	That concept		That direction (of a revolution in the environment).

A study of the last formula will render it evident that the whole difference between right thinking and wrong thinking lies in the relation between the organismal term and the environmental term. If the relation is properly adjusted, as in the above instance, then the thought is correct, valid, true. But if the relation in the mind is improperly adjusted to the relation in the environment, then the thought is incorrect, invalid, untrue. Such a thought is represented by the following formula:—

Organismal Term.	Relation.	Environmental Term.
The concept (of the direction of the current at the north pole of a solenoid)	corresponds with (but is not properly adjusted to)	The direction of the current of the solenoid
is unlike		is like
The concept (of the direction of the revolution of the earth)		The direction of the revolution of the earth.

The attention of the reader is particularly directed to the construction of this formula—to the correspondence of the relation in the organism with the relation in the environment which it displays; since this aspect and this mode of dealing with mental states is of the very utmost importance to the alienist. Indeed, it is impossible to obtain an adequate or satisfactory notion of the nature of insanity, or of the various ways in which the mind may be disordered, without thorough comprehension of, and continual reference to, the doctrine that these formulæ express. Both the purely introspective view of mental relations, and the view which regards them in correspondence with their environmental counterparts, are of vital importance, not merely to the general student of mind, but also and especially to the alienist; for the first enables him to divide the whole class of cognitions into groups of manageable dimensions, while the second teaches him to investigate the precise form of disorder that may affect any thought or group of thoughts, and to say precisely in what manner and to what degree it is disordered.

I want my purse. I remember that it is on the mantelpiece, and I go and find it there. What is the nature of the mental operation that I call "remembering" the position of the purse? It is the occurrence of a relation between the idea or mental image of the purse and the idea of a certain locality. These two ideas arise in contiguity to one another; they cohere, so that the rising of one of them into consciousness drags the other after it. I can if I please dissociate the two ideas. I can bring the mental image of my purse into relation with other mental images. I can think of it as on the table or on the bookcase, but these relations are feeble. The ideas do not cohere with the tenacity of the first pair; and when I wish to get the purse I go neither to the table nor the bookcase but to the mantelpiece. Why does the mental image of the purse cohere more tenaciously with that of the mantelpiece than with any other? Because, we say, the purse was last seen there; because I remember putting it there. In other words, the idea of the purse arouses more readily and coheres more tenaciously with the idea of the mantelpiece than with any other idea, because this pair of ideas have been more recently experienced in a vivid form than any of the other pairs. The remembrance is the recurrence or revival of a relation that had been experienced before; it is the *representation* of a relation; and this is the nature of every process of remembrance—of every exercise of the memory.

But suppose that I cannot recollect where I put the purse. I search the room to find it, and presently come upon it on the corner of the mantelpiece. I have now the same pair of ideas in the same relation as when I remembered the position without seeing it. And in this case as in that, the relation is the revival of a relation that I had experienced before. I must have had these two ideas in this relation when I placed the purse there. Here again is a case of the revival of a relation that had been experienced before; but I do not call this a remembrance. When I see the purse, I do not say that I remember where it is. I say that I *perceive* where it is. What, then, is the difference between the previous case of remembrance and the present case of perception? The difference is in the vividness of the ideas. In the remembrance, both the idea of the purse and that of the mantelpiece were faint, shadowy, representative. In the present case of perception, both these ideas are vivid, intense, presentative; and this is the difference between the two processes.

Not in every case of perception are both the terms of the relation presentative. When my purse is lying before me on the table I perceive that it is there, and in that perception both terms—both the idea of the purse and the idea of the table—are presentative. But if, instead of paying attention to its position, I pay attention to other attributes, I shall presently come to some that are not presentative. I perceive that it is what is called a purse; and I know this without hearing the sound "purse." In this case the cognition consists of the cohesion in consciousness of two terms. One term, the idea of the oblong brown object lying before me, is presentative, insomuch as the object is presented to my senses. The other term, the idea of the word "purse" is representative, insomuch as neither the sound, nor the feeling muscular movement corresponding with the sound, is present in consciousness with the vividness and intensity that imply actuality. The cognition is presentative-representative, one term being presented and the other represented.

If we examine the matter more closely we see that even the first of these two terms is not wholly presented. The patch of brown colour of various degrees of brightness and shadow is all that is actually present to my senses. I do not see the shape of the thing. I infer the shape, I unconsciously build up the idea of the shape out of the ideas of innumerable previous experiences of muscular movement.[1] These muscular movements are not experienced now. They are not even revived now in their discrete form. The ideas of the shape and solidity of the object before me are consolidated out of innumerable experiences of my own and of my ancestors. They are in a very high degree representative. Hence we see that in the cognition "this object is a purse," not only is the term purse wholly representative, but the other term, consisting of the idea of the object, is also to a very large extent representative. It is more correct, therefore, to speak of such ideas as that of an object perceived, not as presentative, but as containing presentative elements.

So regarded, the thoughts that consist of the revival of a relation that has been previously experienced are of three kinds: those in which both terms contain presented elements; those in which one term only contains presented elements; and those in which neither term contains presented elements, but both are wholly representative. The latter class of thoughts are memories, the two former are percepts.

Distinct from all these three kinds of thoughts are those which consist of a relation that has never been experienced before, but is now experienced for the first time. It is manifest that the difference between establishing a new relation and reviving a relation that has been established before is greater than the difference between two revivals, even if the relations revived are widely different from one another. When we consider the establishment of a new relation, we are considering a different method of thinking, resulting in a class of thoughts different from all that have gone before.

In this cage, that I now see for the first time, there is a bird. I see no door to the cage, and upon careful search I cannot find a door; but I am convinced that the cage has a

[1] The student who is unfamiliar with the analysis of mental states is referred to special treatises with respect to the composition of our ideas of visible form, etc.

door. Neglecting for the present the process by which the conviction is reached, the question is, What is the nature of this conviction in terms of relations between ideas? Manifestly it is the establishment of an entirely new relation—of a relation which has never before been experienced, between terms that have never before been brought together. The idea of the bird in that cage is brought into relation with the idea of a door in the walls of the cage, and straightway there is established in the mind a relation of coexistence between these two ideas. Written in full, the form of the thought is, The presence of the bird in that cage coexists with the presence of a door in the cage. I do not perceive that the cage has a door. I do not remember that it has a door. I *reason* that it must have one; and this bringing together of two ideas into a new relation is a ratiocination. It is the common form of all reasoning, which may be defined as the establishment of new relations in consciousness. When a correspondent fails to answer an important letter, I infer that he is away from home. What is the nature of this inference? It is the establishment of a relation between the idea or mental image of my correspondent and the idea of his home. Written at large, the thought is, The present position of my correspondent does not coexist with the position of his home. How I reach that conclusion, by what series of steps I attain to that thought, is a matter that does not now concern us. The form of the thought when gained, and the nature of the process of cognising it, are all that we are now dealing with. This form is, as has been said, a new relation, and this process is the establishment of a new relation. When a physician investigates the symptoms presented by a patient, and, after weighing them in his mind, arrives at the conclusion that she is suffering from cancer, the process is the same. The group of ideas that he has gained by his investigation is brought into relation, first with the group that constitutes his mental image of this disease, and then with the group that constitutes his idea of that. Between each pair of groups a relation of similarity or dissimilarity is established; and since the similarity is most complete when his new group arising from his investigation is united with that old group which constitutes his notion of cancer, this is the relation that coheres. The tentative process of establishing one relation after another is the process that we call weighing in the mind, considering, deliberating, and the final establishment of the most coherent of these relations—of the relation of greatest similarity—is the process of coming to a conclusion or forming a judgment. When a meteorologist is advised of the approach of a barometric depression from a certain region in a certain direction, and thereupon predicts that a gale of wind will pass over certain counties with such and such veering and backing, he has established a relation of sequence between one group of ideas and another group of ideas; and when we say that his prediction expresses his opinion, we mean that it expresses the relation that he has newly established; and similarly of every other case of reasoning.

Thoughts, or relations between mental states, are therefore of two chief kinds: those in which there is the establishment of a new relation, and those in which there is the revival of a relation that has been established before; and the latter class are again divided according, as there are presentative elements in both terms of the relation, in one term, or in neither. In tabular form the classification of Thoughts is as follows:—

<table>
<tr><th></th><th></th><th></th><th>The process is termed</th><th>The results are termed</th><th></th></tr>
<tr><td rowspan="4">Thought or Cognition. The occurrence of a relation between conscious states.</td><td colspan="2">Establishment of a new relation.</td><td>Reasoning.</td><td>Judgments.</td><td rowspan="2">Concepts.</td></tr>
<tr><td rowspan="3">Revival of a previously-established relation.</td><td>Both terms are wholly represented.</td><td>Remembrance.</td><td>Memories.</td></tr>
<tr><td>One term only contains presented elements.</td><td>Perception.</td><td rowspan="2" colspan="2">Percepts.</td></tr>
<tr><td>Both terms contain presented elements.</td><td>Perception.</td></tr>
</table>

The thorough comprehension of the nature and varieties of Thoughts from that point of view which regards them as relations between conscious states, is of such paramount importance as well to the student of morbid as of normal psychology, that too much stress can scarcely be laid upon it; and believing that an additional presentment of the whole case will bring the matter more thoroughly home to those who are unfamiliar with this mode of regarding cognitions, I will reproduce here the substance of an argument published in *Mind,* No. XXX., in which I examined Mr. Spencer's classification of cognitions, with the object of superseding it by the classification given above. As, moreover, the main body of the doctrine in this book is avowedly founded upon Mr. Spencer's *Psychology,* it is desirable to state *in extenso* my reasons for dissenting from such portions of his psychology as I do not accept. The argument as here reproduced is somewhat modified from its original form.

Mr. Spencer's classification of Cognitions is, as is well known, as follows:—

Presentative cognitions, or those in which consciousness is occupied in localising a sensation impressed on the organism—occupied, that is, with the relation between this presented mental state and those other presented mental states which make up the consciousness of the part affected, as on cutting one's finger.

Presentative-representative cognitions, or those in which consciousness is occupied with the relation between a sensation, or group of sensations, and the representations of those various other sensations that accompany it in experience. This is what we commonly call perception—an act in which, along with certain impressions presented to consciousness, there arise in consciousness the ideas of certain other impressions ordinarily connected with the presented ones, as when its visible form and colour lead us to mentally endow an orange with all its other attributes.

Representative cognitions, or those in which consciousness is occupied with the relations among ideas or represented sensations, as in all acts of recollection.

Re-representative cognitions, or those in which the occupation of consciousness is not by representations of special relations, that have before been presented to consciousness, but those in which such represented special relations are thought of merely as comprehended in a general relation. Here the concrete relations once experienced are, in so far as they become objects of consciousness at all, only incidentally represented, along with the abstract relation which formulates them. The ideas resulting from this abstraction do not themselves represent actual experiences, but are symbols which stand for groups of such actual experiences—represent aggregates of representations. And thus they may be called re-representative cognitions. It is clear that the process of re-representation is carried to higher stages as the thought becomes more abstract.

This classification appears to me to be erroneous—to group together thoughts that are widely unlike, and to separate others that are closely similar. The groups are, as I shall endeavour to show, wanting in definition, and their definitions may be made to cover cognitions that were not intended to enter the group, and to exclude others which it ought to contain.

As to the first class, that of presentative cognitions, Mr. Spencer would surely be himself the first to admit that all cognitions, even those here classed as presentative, contain represented elements. When I cut my finger, the sensation of smarting pain is indeed presented, but the mental states that make up the consciousness of the part affected, although many of them are presented, yet include also a crowd of others that are wholly represented. Mr. Spencer has elsewhere worked out with unrivalled analytical skill the process by which an individual builds up a knowledge of his own organism; and, on his own showing, the mental states which make up the consciousness of the part affected, must include representations, more or less distinct, of all those muscular, tactile, and other sensations by which this part became known as distinguished from other parts. That such cognitions as that instanced above require a separate place in a classification is clear, but that they can be classed as wholly presentative cannot be admitted.

The class of Presentative-representative cognitions is susceptible of division into two by a distinction which, though not at all sharply defined, is yet very important. Those cognitions, of which Mr. Spencer's example of the orange is a type, and which constitute the class of ordinary percepts, form only one of these divisions. Suppose, however, that the object presented to my senses, instead of being an orange, is a bael fruit; and suppose that this object is quite new in my experience. After an examination of the fruit, followed perhaps by an examination of the parent plant, I decide that although not an orange, it belongs to the natural order Aurantaceæ. In this case it cannot be said, in the terms of Mr. Spencer's classification, that consciousness is occupied with the relation between a sensation or a group of sensations, and "the representations of those various other sensations which accompany it in experience;" for the group of sensations composing the consciousness of the bael fruit has never been experienced before. Yet the cognition is a presentative-representative one, for consciousness is occupied with the relation between a group of presented sensations (those answering to the characters of the fruit) and a group of represented sensations (answering to the characters of the natural order Aurantaceæ). So that, while the cognition is undoubtedly presentative-representative, inasmuch as one term contains presented elements while the other does not, yet it is excluded by the definition from Mr. Spencer's group of Presentative-representative cognitions.

Mr. Spencer's next class—that of Representative cognitions—consists of "those in which consciousness is occupied with the relations amongst ideas or represented sensations, as in all acts of recollection." It seems clear from this expression, as well as from the name of the group and its position in the scheme of classification, that this class includes representations of the cognitions belonging to the previous classes only; the word "or" appearing to mean that the term "represented sensations" is an equivalent substitute for the term "ideas." If this is a correct interpretation of Mr. Spencer's meaning, the group is open to a double objection. In the first place, it includes more than acts of recollection; and in the second place, it includes more than representations of the previous classes of cognitions. For if I am unable to determine the natural order of the bael plant, while it is actually under examination, but upon subsequent reflection, when I no longer have it before me, I am able to refer it to its position, it is clear that this is a cognition in which consciousness is occupied with the relations of represented sensations. Of the relation which constitutes the cognition, the represented sensations corresponding with the characters of the bael fruit form one term, and the represented sensations, corresponding with the characters of other Aurantaceous plants, form the other term. Yet this determination of the natural order of the plant is not an act of recollection. It is a process of reasoning; and hence, although strictly representative, it is excluded from Mr. Spencer's class of Representative cognitions.

The artificial character of Mr. Spencer's classification appears to me well demonstrated by the same example. If I have both the bael and other Aurantaceous plants before me, the determination of the natural order of the former is a Presentative cognition. If the bael plant is present, while for the characters of other Aurantaceæ I have to depend on my memory, the same process is a Presentative-representative cognition; while if the bael also is remembered, the same process belongs to yet another class—that of Representative cognition.

To return to the consideration of the latter class, not only does it exclude cognitions, such as the judgment instanced, that are strictly representative, but it includes also cognitions of the highest degrees of re-representativeness. For it is manifest that cognitions of the most abstract and re-representative character admit of recollection even more perfectly than do cognitions that contain presented elements. As the remembrance of a presented sensation is never so vivid as the presented sensation itself, so the cognition into which a represented sensation enters can never be as vivid as the cognition in which the sensation was actually presented. But a highly re-representative cognition may be as vivid during its remembrance as during its original conception. If Mr. Spencer meant to include among Representative cognitions the recollection of re-representative cognitions, then I would submit that not only is the definition imperfect, but that the position of the class of Representative cognitions should be above instead of below that of Re-representative cognitions; since if these latter are remembered, that is represented, the remembrance adds one more grade of representation to their already highly re-representative character.

The objections advanced against the classification by degrees of representativeness may be summed up as follows:—The terminology of such a classification is misleading, since first it leads us to distribute some cognitions into classes from which the accompanying definitions would exclude them; and second, it implies that one or both terms of a cognition may be entirely presentative, which is not the case; and in such a classification no place is found for judgments, apart from memories and percepts.

The alternative classification that I proposed in 1883 is the same as that already explained, but the following exposition of it is needed in order to set forth fully and clearly the distinctions on which it is founded, and the differences that separate it from Mr. Spencer's:—

CLASS I.—*The cognition is the revival in consciousness of a previously established relation.* Cognitions of this class admit of division into these sub-classes as already set forth.

(*a*) *Both terms of the revived relation contain presented elements.* This sub-class is coextensive with Mr. Spencer's class of Presentative cognitions; but the form of statement here adopted avoids the inaccuracy which appears to me to exist in his definition of that class. In the case which he instances of the cut finger, there is a relation established between the presented sensation of the smart from the wound and the mental states, some presented and some represented, which make up the consciousness of the part affected. While both terms contain presented elements, only one is entirely composed of them, the other being partly represented. Cognitions belonging to this sub-class are those percepts, which being of the lowest and least differentiated form, merge on the one hand into sensation and on the other into reasoning.

(*b*) *One term only of the revived relation contains presented elements.* These cognitions are the results of the process of Perception in the ordinary sense of that term. They are what are ordinarily meant by the term Percepts. The difference between the perception of an orange and the classification of a bael fruit clearly is this. The group of mental states corresponding with the group of characters (of colour, form, size, etc.), partly or wholly presented by the orange, has previously been brought into relation with the mental states corresponding with the other characters (of succulence, consistence, odour, texture, etc.), which are not now presented, but are represented in consciousness; and the revival of this previously established relation is the process of Perception. On the other hand, the group of mental states corresponding with the characters presented by the bael fruit has never before been present in consciousness. It has never therefore been a term of a mental relation. It has now to be brought into relation with other groups of states, either presentative or representative, until a group occurs with which a relation of similarity can be established. The establishment of this new relation constitutes a process of Reasoning, and the character of this process is in no way affected by the presentative or representative character of the terms that are brought into relation. The next time the bael fruit is brought under notice, it is *perceived* to belong to the orange family, the perception being the *revival* of the relation that was established on the first occasion. Of course, the fruit was perceived in a colloquial sense the first time it was seen; but the perception amounted only to its perception as a solid vegetable product, probably a fruit,—that is to say, so far as it was seen to resemble other solid bodies, other vegetable products, and other fruits;

in other words, so far as there was a revival of relations previously established between ideas of similar presented characters, and ideas of similar characters possessed but not presented, so far there was Perception. But those cognitions, whose terms had not previously been brought together in consciousness,—that is to say, those by which its characters were found to resemble the characters of other Aurantaceous plants—were processes not of Perception but of Reasoning. It may be said that since no two objects are precisely alike, nor does even the same object ever present a second time precisely the same group of characters to observation, perception as here defined cannot exist; but this is an unnecessary refinement. As in the external world there is every degree of difference between groups of characters present now and groups of characters previously present, so in consciousness there is every degree of gradation between perception and reasoning; but, although not abruptly demarcated, the processes are none the less broadly distinguishable.

This second sub-class of cognitions is coextensive with the presentative-representative cognitions of Mr. Spencer, as he defines them, and with the first of the two groups into which, as explained above, that class seems to me to be divisible. In this case again the view here upheld appears to express the nature of the cognition with greater accuracy. For, as already pointed out, an ordinary perception is not a presentative-representative cognition in the sense that one term is wholly presentative, while the other alone contains representative elements. In Mr. Spencer's own example of the orange, the visible form, which is part of the presentative term, is composed of elements part presentative but largely also representative. Hence it seems to me more correct to speak of percepts as cognitions of the first class, one term of which contains presented elements.

(*c*) *Both terms of the revived relation are wholly representative.* This is the process of Remembrance. The resulting cognitions are Memories. It includes part of the Representative cognitions of Mr. Spencer, together with all re-representative cognitions that are revivals of cognitions previously established, no matter how high the grade of re-representation may be, or, which is the same thing, how remote the terms may be from direct presentation. On the other hand, all those Representative cognitions in which consciousness is occupied with the establishment of a new relation between terms; however low the terms may be in grade of representativeness, and however often they may separately, or in other relations, have been present to consciousness; since they are excluded from the class, are excluded from the sub-class also.

CLASS II.—*The cognition is the establishment of a new relation in consciousness.* This is the process of Reasoning. It may be carried on between terms of all degrees of representativeness, not excepting the very lowest. When both terms are presented, as in Mr. Spencer's example of the cut finger, it may appear to be straining the sense of words to call any part of the cognition a process of reasoning. Yet if that particular spot has never been cut before, there must be the establishment of an altogether new relation. The terms of the new relation are (the presented sensation known as the smart of the wound) and (the states of mind, part presentative and part representative, which make up the consciousness of the part affected). These two terms are brought into close relation—into a relation of coexistence. They have never before been so related. The relation is now for the first time established; and the establishment of a new relation in consciousness is a process of reasoning. Are we then to say that we arrive at the consciousness of a cut on the finger by a process of reasoning? The assertion appears startling at first sight, and its reception will not be aided by the recollection that a few pages back the same condition of mind was adduced as an example of perception. The inconsistency is apparent but not actual; for it was then stated that the lowest form of Perception, of which this case is an instance, merges into Reasoning on the one hand and into Sensation on the other. It is indeed the common root from which they spring—the starting-point from which they diverge. While the mental process by which we cognise a cut on the finger is from one aspect a perception, it is from another aspect a ratiocination. It is indeed a double process. Although the part has, we suppose, never been cut before, it has been the starting-point of innumerable sensations of touch, pressure, temperature, etc., and these sensations, when combined with innumerable other sensations of muscular exertion and of vision, and represented simultaneously and with various degrees of intensity, constitute the complex mental state forming the consciousness of the part affected. On the other hand, there have been previous experiences of cuts, which enable a new experience of a similar character to be classified with them and distinguished from sensations accompanying other injuries. Now what occurs in the mind when the finger is cut? There occurs, as has been said, a double process. There is (1) the revival of a previously established relation between (some sensation) and (the complex group of states which make up the consciousness of the part affected); and there is (2) the establishment of a new relation between (the quality of this sensation) and (the quality of the represented sensations of previous cuts). There is thus a process of perception and a process of reasoning. That the two processes do occur and are distinct is easily shown. If a blind man were asked how he knew that it was his *finger* that was cut, and not any other part, the question would appear absurd, and if answered at all, it would be by the reply that he *perceived* that it was his finger. But if he were asked how he knew that his finger was *cut* and not bruised, he could only say that he recognised the feeling to be like that of previous cuts. By thus giving a reason he would make the formal admission that he arrived at this cognition by a process of reasoning. Doubtless the process may virtually be called one of perception, and the distinction here made is an analytical refinement; but it is a not inapt illustration of Mr. Spencer's doctrine that Perception, Remembrance, and Reasoning, distinct as they are in their developed forms, blend at their origin, and spring from a common root.

Like the first Class of cognitions, the process of Reasoning and its results admit of sub-division according to the degree of representativeness of the terms between which the relation subsists, but unlike that class, their sub-divisions do not admit of precise definition. Whether the bael fruit is classified from actual comparison of its presented characters with those of other Aurantaceæ, or from comparison of its presented characters with the remembered characters of these, or whether its characters as well as theirs are represented, makes a marked, but not a material difference. Nevertheless, since, "as the process of representation is carried to higher stages the thought becomes more abstract," the degree of representativeness forms an index of the elaborateness, complexity, and abstractness of the reasoning.

The introspective view of mental relations deals with the resemblances and differences of such relations among themselves, but it takes no account of their correctness. When this cognition is regarded as newly experienced, or that one as representative, the question of their truth does not arise. They may be correct or incorrect, and in either case may equally possess the characters that we attribute to them on introspection. The test of the correctness of a cognition is its adjustment to the environmental relation with which it corresponds. If I class the bael fruit in the order Rosaceæ, the classification is as much an exercise of Reason as if I class it in its proper order. The cognition may be either entirely representative, or may have presentative elements in one or both its terms. It is as much a judgment as the correct cognition, and, introspectively considered, it is entitled to precisely the same rank and status. The relation which constitutes the cognition is—(the characters of this fruit) are identical with (the characters of a Rosaceous fruit), and so long as we confine ourselves to this relation, we have no means of knowing whether the cognition is correct or no. Only when we examine its correspondence with the environmental relation can this be done. When we so regard the cognition, the incorrectness not only comes into view, but is by far the most striking and conspicuous feature in the presentment, as the following expression will show :—

Mental Relation.		Environmental Relation.
The idea of the characters of this fruit is identical with the idea of the characters of the Rosaceæ.	corresponds with	The characters of this fruit are different from the characters of the Rosaceæ.

Herein lies the immense importance of this view of cognition to the alienist. By it, and by it alone, he is able to apply the qualitative test whether the mind of his patient is disordered, and by what kind of disorder it is affected. By it, and by it alone, he is able to determine quantitatively what degree this disorder has attained. With the method of prosecuting this inquiry we are not now concerned. Our present business is to afford a basis upon which such an inquiry may be conducted, and this basis is to be found in the observation of the adjustment or non-adjustment of the mental relation to the relation in the environment; and, if the adjustment is faulty, in the observation of the kind and degree of the defect.

While the general question of the failure of adjustment of the mental relation to the environmental relation belongs to the domain of alienism, and therefore does not now present itself for consideration, there is a particular case of this failure which lies wholly within the province of the normal, and which may, therefore, properly be considered here. This is the occurrence of Mistakes; and at this point the utility of considering the establishment of a relation in the mind separately from the adjustment of this relation to its corresponding environmental condition becomes conspicuous. For in a mistake the error is primarily in the one process, while in a delusion or other insane disorder of the mind it is the other process that is primarily in error.

In such a mistake as that instanced above, in which an Aurantaceous plant is wrongly referred to the Rosaceæ, the first error evidently lies in the establishment in the mind of a relation of identity between two ideas that are not identical. It may be said that the ideas are identical. The bael plant has been wrongly perceived, or the characters of Rosaceæ have been wrongly remembered, and thus the two ideas are identical, although they ought not to be so. Let us grant that this may be so. Although the error is taken a step further back, it is still in the mental relation. If the plant has been wrongly perceived, the error is that its presented characters have roused the wrong set of represented characters—an error entirely comprised within the mind, as will presently be shown. If the characters of the Rosaceæ have been wrongly remembered, this error is manifestly a mental one. In any case the wrong relation has been established. There can be no question that the establishment of the mental relation is the process that is primarily in error. The question is, Is the process of adjusting this relation to the environmental relation with which it corresponds, equally or more than equally faulty? It is not. It is not in fault at all. It is true that the two relations are unadjusted, but this is not because the process of adjusting them is in fault, for it can be brought into action and readjustment effected. Closer examination of the bael plant, the advice of a friend, reference to a description of the Rosaceæ, may so alter the mental relation as to turn the affirmative into a negative, and so produce a perfect adjustment to the environmental relation; and so long as this adjustment can be completely effected, so long the process of effecting it cannot be disordered. Note how the adjustment is rectified. It is not solely by a rearrangement of the mental states. The relation between the two mental states is indeed altered, but how? By applying the mental relation to the environmental relation and observing the discordance between them. By comparing the first term of the one with the first term of the other, and the second term of the one with the second term of the other, and finally modifying the relation between the first pair of terms into accordance with the relation between the second pair. The rectification is a readjustment of the relation in the organism to a relation in the environment, and its completion is proof that the process of adjustment is sound.

In insane disorder of the mind, on the other hand, the sequence of mental states may or may not be disordered. In many cases the amount of disorder that they suffer is scarcely or not at all appreciable. Many a lunatic is extremely, surprisingly, intelligent; and his intelligence is often adduced by the laity in proof of his sanity. Every alienist knows by frequent experience that intelligence and sanity are widely distinct, and are often not coexistent; but no one has explained wherein the distinction lies. Every one will admit that the rudest and most ignorant boor may be perfectly sane, while the most highly educated and intelligent man of science may be insane; and this admission is alone enough to prove that intelligence and sanity are totally distinct; but then the question arises, What is the distinction between them? The distinction has already been stated. It remains to prove that the statement is correct. Suppose that a man meditates upon the evils of a precarious, though large income; upon the insecurity of speculative investments; upon the worry and anxiety inseparable from the ownership of a large amount of fluctuating securities; and on the comfort and ease obtainable from a smaller but more certain income. He notices that his health is not so good as it was; his appetite fails; he sleeps badly; his hand is unsteady; his mind is not so clear as it used to be; he has less confidence in himself; so he resolves to write to his broker and instruct him to close all his speculative accounts, to realise every penny that he can obtain, and to invest the whole proceeds in consols. And he does write accordingly. He enumerates all his investments, their amounts, the current price of the stocks, deducts the brokerage, and calculates the sum remaining to invest. Then he sits down with the placid conviction that he need never again have cause for anxiety about pecuniary matters. But all this time he is a pauper inmate of a lunatic asylum, and has not a farthing of his own in the world. Here there can be no question of the absolute healthiness of the series of mental operations which lead up to and culminate in the act of writing the letter. The operations are highly complex. They are prudent. They are normal in every respect, save only that they are not adapted to the circumstances in which the individual is placed; they are not adjusted to the particular environmental conditions. Those parts of the mental operations which do not directly refer to the special environmental conditions of the individual,—that is to say, the general propositions—are in all respects perfectly normal both as mental states *per se*, and as mental states adjusted to environmental circumstances. When he resolves to take the course which commends itself to him, the operations are still perfectly normal as mental operations *per se*. The course is prudent, the calculations are correct; the prices agree with those of the market; the train of reasoning is without a flaw, but it is founded on a wrong conception of external circumstances. The mental states are properly adjusted to one another, but they are not adjusted to the relations in the environment. The process of establishing relations in the mind is intact. What is at fault is the process of adjusting these relations to the environmental relations with which they correspond. On the concepts that he has already in his mind he can reason correctly—he can establish new and valid relations between them. But he cannot modify them in accordance with the altered external circumstances. For next morning he gets a letter from his broker to say that he has no assets. The securities that he has ordered to be sold were disposed of long ago. He is penniless. On receiving this letter he is perhaps shocked for a moment; or he is indignant and treats it as a fraud; or he pays no attention to it—does not appear to realise the statements it contains. In any case, a few hours after he goes through his previous train of reasoning, comes again to his former conclusion, and writes another letter the counterpart of the first. Here is proof positive of the nature of the process that is disordered. Furnished with all the means of readjusting his mental relations to the relations in his environment, he fails to make the readjustment. The mental relations, considered among themselves, are as before good, valid and correct, but their correspondence with external relations is not only unadjusted, but is incapable of being adjusted. The process of adjustment is disordered, and the adjustment cannot be made.

In a mistake, therefore, the mental relation is unadjusted to the relation in the environment; but the process of adjustment being intact, the mental relation can, if the appropriate circumstances are present, be modified so as to bring it into harmony with the environmental relation. In insanity also the mental relation is unadjusted to the relation in the environment; and in this case the process of adjustment being disordered, the two relations cannot be brought into harmony. If we indicate by a bracket the process that is disordered, then a mistake may be graphically represented thus—

$$\begin{array}{ccc} \text{Mental Relation.} & & \text{Environmental Relation.} \\ \left\{\begin{array}{l} a \\ : \\ b \end{array}\right. & \text{corresponds with} & \begin{array}{c} A \\ : \\ B \end{array} \end{array}$$

While an insane delusion will be represented thus—

$$\begin{array}{ccc} \text{Mental Relation.} & & \text{Environmental Relation.} \\ \begin{array}{c} a \\ : \\ b \end{array} & \overbrace{\text{corresponds with}} & \begin{array}{c} A \\ : \\ B \end{array} \end{array}$$

It will be seen that an important distinction is drawn between the fact of the relations being unadjusted and the process of adjusting them. The difference between them is as great as the difference between the fact that this is the wrong key and the process of finding the right one.

Of course an insane person may make mistakes; and he is not less liable to do so than other people. But his insanity does not consist in making mistakes; it consists in his inability to recognise that they are mistakes, when the conditions requisite for making such a recognition are afforded him. Of course also the fact that a mental relation is unadjusted to its environmental relation does not stamp it as an insane cognition; it is the inability to appreciate the non-adjustment under appropriate circumstances, and to bring about readjustment, that constitutes the insanity.

Dealing here with normal processes only, we are not called upon to pursue this subject any further. It is sufficient for the present purpose to show where the normal abuts upon the abnormal, and to trace, as clearly as the nature of the case admits, the line of division between them. Too much stress cannot, however, be laid upon the distinction here drawn between the process of establishing relations in the mind, and the process of adjusting these relations to external circumstances. Without a clear recognition of this distinction scientific alienism is impossible, and no adequate concept of insanity can be formed.

Underlying the whole of the preceding argument there is one fundamental assumption. It is postulated that there is an external world and that this can be known. When we speak of the agreement of a mental relation with a relation in the environment, it is assumed that there is an environment, and that we have means of knowing and testing whether our concepts are or are not in agreement with the circumstances in this environment. Into the question of the existence of a world outside of our own minds it is no part of the business of psychology to enter. That is a matter which is the concern of philosophy, not of psychology. But as to our means of verifying our concepts a few words may be said. We have, of course, no means of comparing our concepts with the state of things actually existing in the environment; with the noumenal external relation. All verification is the comparison of representative cognitions with presentative cognitions. We are obliged to assume that the presentative cognitions — the cognitions formed during actual experience of external relations—correctly represent those relations. If I am doubtful whether the number of this page is 252 or 232, I test my cognition by looking to the top of the page, and, by the number that I see printed there, I am bound. I compare my representation of the percept with the presented percept, and further than that I cannot go. And I do not need to go further. If my sight is bad or the light is faint, I may use a magnifying glass or bring the page into a better light,—that is to say, I may take means to ensure that the presentation is vivid and distinct. But once I have got a definite, distinct, presentative cognition I am bound by it, and I can carry the test no further. I must take that cognition as evidence of what exists in the world outside me.

I am bound to take every precaution to verify the evidence of one sense by the evidence of another; but when, by the concurrent evidence of several or all my senses, I get a distinct presentative concept, I have no alternative but to accept that as conclusive evidence of the environmental circumstances.

Then, it may be said, the defect in insanity is reduced to an inability to adjust, not the mental relation to the environmental relation, but representative relation to a presentative one. Yet this objection would not be valid, for the defect in insanity is not always this, and is sometimes more than this. The comparison of a representative cognition with a presentative cognition is in colloquial terms "referring to facts," *i.e.* to the evidence of our senses. This is our last resort in verifying our knowledge. But we do not always need to have recourse to our last resort. If it is suggested to me that I have £100,000 at my bankers, I do not need to refer to my banker's book to test the truth of the suggestion. That must be my proof in the last resort, but I do not need to have recourse to it. If I entertained the delusion that I have this sum in the bank, then clearly my mental relations are unadjusted to the circumstances in my environment. To convince me that it is not there, my friends show me the bank book, take me to the bank and interview the managers; in other words, they procure for me abundance of presentative cognitions to compare with the representative one that is erroneous. But all is of no avail. I only shift the question further back and say that friends and bank and all are in a conspiracy to defraud me. From this hypothesis there is no appeal save to its inherent improbability—to the lifelong evidence of integrity that they have given; and this does not admit of being presented directly and perceived in a presentative cognition.

I have elsewhere (*Journal of Mental Science*, Jan. 1882) endeavoured to prove that Insanity consists in disorder of the process of adjustment of the organism to its environment, and have there shown at considerable length that this holds true of all objective manifestations of insanity—of insanity as manifested by Conduct. The present discussion is the correlative of that one, and if valid, indicates that this formula is as true of the subjective or mental disorder as of the objective disorder or disorder of behaviour.

CHAPTER XI

FEELING

FEELING, like Thought, admits of being regarded both introspectively, in comparison with other feelings, and as corresponding with circumstances in the environment. As in the case of Thought, the introspective view of Feeling, while it affords useful and indeed indispensable knowledge, does not afford the knowledge that our first parents sought to attain—the knowledge of right and wrong. It does not teach us how to distinguish correct feelings from mistaken feelings, or mistaken from morbid ones. Nevertheless it gives us information which is indispensable, and can be attained in no other way. The introspective view of feeling reveals the most tremendous distinction that animated beings are concerned with—the distinction between pleasure and pain. What are the intrinsic natures of pleasures and pains, considered psychologically, appears, Mr. Spencer says, an unanswerable question; nor is it necessary for the purposes of the alienist to answer it. But when we remember that pleasures and pains furnish the motives for all Conduct—for every act of our daily lives—and that by them our whole lives are guided, it is not claiming too much to say that these qualities of feeling deserve some consideration at the hands of those whose profession it is to study human minds and human conduct.

As to the characters of pleasures and pains, introspectively considered, Mr. Spencer makes the following observations:—"Pleasures to a large extent, and Pains to some extent, are separate from and additional to the feelings with which we habitually identify them. If I hear a sound of beautiful quality, an agreeable state of consciousness is produced; but if this sound is unceasing, or perpetually repeated, the state of consciousness loses its agreeableness without otherwise changing. A glow of delight accompanies the sight of a fine colour; but after having the colour before the eyes for a long time, there remains only the consciousness of its duality—the delight is gone. Similarly, if I go on tasting something sweet, there comes a time when the gratification ends, though the sense of sweetness continues. Doubtless the sense of sweetness itself eventually becomes deadened; but the gratification gives place to nausea before this happens. Among pains the parallel fact is less conspicuous; but it is not difficult to perceive that along with the localised pain, say of a bruise or a burn, there goes an element of distress that is not localised.

"The second of these allied truths, illustrations of which serve in part to re-illustrate the first, is that Pleasures and Pains may be acquired—may be, as it were, superposed on certain feelings which did not originally yield them. Smokers, snuff-takers, and those who chew tobacco, furnish familiar instances of the way in which long persistence in a sensation not originally pleasurable, makes it pleasurable—the sensation itself remaining unchanged. The like happens with various foods and drinks, which at first distasteful, are afterwards greatly relished if frequently taken. Common sayings about the effects of habit imply recognition of this truth as holding with feelings of other orders. That acute pain can be superinduced on feelings originally agreeable or indifferent, we have no proof. But we have proof that the state of consciousness called disgust may be made inseparable from a feeling that was once pleasurable. The extreme repugnances shown by children to the sweet things given along with medicines are illustrations; and probably nearly every one can furnish from his own experience some instance of acquired aversion of another order.

"The third of these allied facts is that Pleasures are more like one another than are the feelings which yield them, and that among Pains we may trace a parallel resemblance. The wave of delight produced by the sight of a grand landscape, is qualitatively much the same as that produced by an expressive musical cadence. There is close kinship between the agreeable feelings aroused, the one by a kind word, and the other by a highly poetical thought. Nay, it needs but to mark the accompanying expression of face, to perceive that even the pleasure which an exquisite perfume yields, is to a considerable extent of the same nature. Indeed, the frequent application of the words sweet, delicious, etc., to things and acts of all kinds that yield great pleasure, shows that this similarity is habitually recognised. Pains display this kinship still more conspicuously. Though the ordinary feelings of heat, of pressure, and of muscular tension, resemble one another but little, yet when they are severally raised to high intensities, the resulting pains are nearly allied. Indeed, there is an obvious family likeness among all the peripheral pains when intense, and among all the central pains when intense.

"These three general facts taken together, warrant the suspicion that while pleasures and pains are partly constituted of those local and conspicuous elements of feeling directly aroused by special stimuli, they are largely, if not mainly, composed of secondary elements of feeling aroused indirectly by diffused stimulation of the nervous system."

As a corollary of Mr. Spencer's first fact may be mentioned the familiar observation that the same feeling that is pleasurable to one person, is disagreeable to another.

Concerning the immensely important subject of the physiological significance of pleasure and pain, I have nothing to add to what Mr. Spencer says. Reference to his *Principles of Psychology*, vol. i. § 122 *et seq.*, will probably serve to convince the reader that pleasures are the mental states that attend actions that are beneficial to the organism, while pains are those which attend actions that are hurtful. I may say that I had arrived at this conclusion before I had read of Mr. Spencer's writings, and that this fact may be considered an independent corroboration of the truth of the doctrine.

In addition to their qualitative distinction as pleasurable or painful, feelings admit of a quantitative division, according as they are vivid or faint. When I look at a grass plot, I have a feeling of green. When I close my eyes and think of the plot, I have a feeling of green. But the two feelings differ immensely in vividness. In the first case, in which the feeling is extremely vivid, I refer it to the present existence of something outside of me whose action on me arouses the feeling. In the second case, in which the feeling is faint, I do not so refer it. The one feeling is presentative—aroused by an object presented to the senses; the other is representative—is a representation of a former feeling. Now it is to be observed that although all feelings admit of being experienced in several degrees of vividness, yet all do not admit of this abrupt distinction into vivid and faint. The feeling of sorrow that I had yesterday when I saw my friend break his leg, was not a whit more intense than it is now when he is not present. The feeling of embarrassment that I experience on the remembrance that I broke down in a speech yesterday, is scarcely less intense now than it was at the time. The difference between the two feelings is certainly not comparable with the difference between the vivid feeling of green and the ideal representation of the same feeling. Nor does this want of contrast hold true only of cases, such as those just instanced, of feelings that are somewhat elaborate. It is true also of some feelings on a lower level. To rub rough brown paper with the fingers produces in me an intensely unpleasant feeling of the teeth-on-edge variety. When I see and hear any one else doing the same thing, the feeling is as intense as when I do it myself. And even the thought of doing so arouses a feeling which, if not as vivid as the presentative feeling, differs from it by a comparatively small degree. While, therefore, the quantitative distinction between feelings is in some cases extremely broad, it is in others under corresponding conditions very narrow, and the rationale of this difference in different cases is not clear. Still it is important to bear in mind that one of the main distinctions between feelings on introspective view, a difference second in importance to the qualitative distinction only, is the difference in vividness that they present.

A further division, differing from both the foregoing and often important in practical investigations, is the distinction pointed out by Professor Bain between feelings that are acute or intense and those that are voluminous or massive. "A sharp prick in the finger, or a hot cinder yields acute sensations; the contact of the clothing of the entire body, or a warm bath, yields voluminous or massive sensations. . . . The contrast is noticeable in every one of the senses. A gas-flame gives an acute feeling; the diffused sunlight gives a massive feeling. A high note on the flageolet is acute; a deep bass note on the violoncello or the organ is massive. The sea, the thunder, the shouting of a multitude are voluminous or massive from repetition over a wide area. Taste is acute, digestive feeling is massive."

A fourth mode of regarding feelings from the introspective standpoint is that which takes account of their presentative or representative character. While the presentative character of a feeling concerns to some extent its vividness, since all presentative feelings are of necessity vivid, yet it is far from being the sole condition that determines the vividness of a feeling; for, as we have seen, many feelings that are not presentative have a vividness little or not at all inferior to that of feelings that are directly presentative, and a feeling, such as indignation, may be re-representative in a very high degree, and yet be extremely vivid; and hence the two divisions—that according to vividness, and that according to presentativeness—do not coincide. The division of feelings as presentative or representative in various degrees is of considerable importance, so much so that Mr. Spencer has founded his main classification of feelings upon this basis. This classification, as will be seen in the next chapter, I do not accept for working purposes, but still the distinctions that it establishes, though vague, are unquestionably important, for they are an index to differences in the elaborateness, complexity, generality, definiteness and other characters of the feelings, and, in short, determine their several grades in the evolutionary scale. The more presentative elements enter into the composition of a feeling, the more elementary is that feeling from the evolutionary standpoint. The more highly re-representative the elements of a feeling, the more elevated is that feeling when considered as the outcome of a process of development. These distinctions, it is to be observed, have no ethical significance. When we now speak of an elevated feeling, what is meant is not necessarily a feeling of a high level of morality, it is one of a high degree of elaborateness. So regarded, feelings are divided by Mr. Spencer similarly to cognitions, into Presentative, Presentative-representative, Representative, and Re-representative; and in that case, as in this, he shows how "increasing integration, increasing definiteness, and increasing heterogeneity of composition are alike measured by the extent to which representation and re-representation have been carried."

Feelings, considered as states of mind pure and simple, may then be regarded qualitatively as pleasurable or painful, in intention as faint or vivid, quantitatively as acute or massive, and in grade of development according to their degree of representativeness. Leaving now the introspective view of feelings, we go on to consider them in their correspondence with external circumstances.

The Nature of Feeling.

In his great work on the *Principles of Psychology*, so often quoted, Mr. Herbert Spencer devotes an entire part of the first volume to the enunciation and enforcement of the doctrine that Mind as well as Life consists in the correspondence of inner actions with outer actions, or of processes in the organism with processes in the environment. Beginning with those lowest organisms which inhabit environments that are extremely simple and practically uniform, he shows that where there is no diversity in the environment, the absence of adaptive changes on the part of the organism is the absence, not indeed of life, but of all those manifestations of life that we class as psychical. Continuing the argument through successive chapters, he shows that, as life advances to higher and higher grades, the correspondence between the organism and its environment progresses in Space, in Time, in Speciality, in Generality, in Complexity, in Co-ordination and in Integration ; and he illustrates and enforces his argument with a wealth of learning, a mastery of presentment, and a dialectical skill that are as admirable as they are conclusive. But when, in the chapter on the "Correspondences in their Totality," he gathers the various strands into a single knot, and sums up the results of his reasonings, instead of concluding as we have been all along led to expect, with an expression of the nature of Mind, he drops into what is almost an anticlimax, and contents himself with formulating the nature, not of Mind, but of Intelligence only—of that Intelligence which he has previously insisted with so much force is a part only, and a minor part, of Mind. When, in the closing paragraph of the last chapter of this part, Mr. Spencer speaks of the various degrees and modes of Intelligence known as Instinct, Memory, Reason, *Emotion*, Will and the rest, we are led to suspect that he has inadvertently used the term Intelligence in substitution for Mind, and that the omission is merely verbal; but this suspicion is negatived, not less by the terms of the formula in which the result is expressed, than by the opening chapters of the succeeding part, which deal with the nature of Intelligence, the law of Intelligence, and the growth of Intelligence, all reference to Feeling and to Mind in its wider sense being abandoned.

Of course no attempt is here made to express the nature of Feeling in itself—of noumenal feeling. Such an attempt must necessarily be as fruitless in the case of the subject as in the case of objects. On introspection, feeling is for us an ultimate fact. We cannot go behind it. But Feeling, like

Intelligence, has its material conditions and its outward manifestations, and on this, its objective side, it can be approached, grappled with, and analysed into its elements. All that is attempted here is to deal with Feeling as Mr. Spencer has dealt with Intelligence, and to express its objective aspect in such terms of the known as, when substituted for it, may give in a definite concept to deal with.

Mr. Spencer's researches into the corresponding aspect of intelligence will prepare us to find that the results of a similar investigation into the nature of feeling will eventuate in an expression in terms of the correspondence between the organism and the environment. That the nature of feeling can be so expressed is demonstrable *a fortiori*. If Life in general, and Mental Life in particular, can be expressed in terms of the correspondence, then, since the whole includes the part, each and every factor of mental life can be so expressed. That Intelligence, one such factor, can be so expressed, Mr. Spencer argues at great length and with irresistible force. That the other factor can be so expressed is my contention. If Intelligence and Feeling grow from a single root and are inseparably involved, as Mr. Spencer shows them to be; and if in their development they become more and more closely interconnected until they are well-nigh indistinguishable, as I have previously maintained; and if Intelligence, one of these two co-ordinate factors, is expressible in terms of the correspondence between the organism and the environment, then Feeling, the other co-ordinate factor, *must* be similarly expressible.

In whatever aspect the question is viewed, this moiety of the subject-matter which is omitted by Mr. Spencer is seen to have an importance even greater than the moiety with which alone he deals—an importance that can scarcely be exaggerated.

On introspective analysis, "Mind," according to Mr. Spencer, "consists mainly, and in one sense entirely, of Feelings. Not only do Feelings constitute the inferior tracts of consciousness, but Feelings are in all cases the materials out of which, in the superior tracts of consciousness, Intellect is evolved by structural combination. Everywhere Feeling is the substance of which, where it is present, Intellect is the form. And where Intellect is not present, or but little present, Mind consists of Feelings that are unformed or but little formed." If this is so, surely it is at least as important to determine the nature of Feeling—the substance—as to determine the nature of Intellect—the form. The analysis of Intelligence, when pursued to its profoundest depth, results in the discovery that Thought is the establishment of relations between Feelings. Underlying this expression of the nature of Intellect there is therefore a deeper and yet more fundamental problem—the determination of the nature of these feelings which form the raw material of Thought. When Intellect is explained in terms of Feeling, is not the unknown explained in terms of the still more unknown? Clearly, the analysis cannot be considered complete until it has been applied to the residuum of unexplained factors.

Or if, instead of viewing Mind introspectively as states of consciousness, we view it in its outward manifestations as correspondence between the organism and the environment, we still find that Mr. Spencer's expression leaves an hiatus even more extensive than the ground it covers. That Intelligence is the correspondence of inner relations with outer relations is evidently a complementary expression, and is as incomplete without its complement as the concept of a wife without that of a husband. According to this expression there is on the one side a series of external relations, and on the other side a parallel series of internal relations, and this is all. But something more than this is required. That one series exhibits changes concomitant or parallel, or corresponding with the changes of the other, is true, but it is obviously not the whole truth. We have as yet got no knowledge of how the one series of changes is brought into relation with the other. Before there can be any adjustment of processes in the organism to external conditions, there must previously have been some influence exercised by these conditions on the organism. This is explicitly stated by Mr. Spencer. "Here," he says, "is an organism placed in the midst of objects. If it is uninfluenced by them, it can know nothing of them, think nothing of them. Their existence cannot be revealed to it unless by the effects they produce on it—the changes they work in it." But this influence exerted by objects upon the organism, although it is an indispensable part of that correspondence between the organism and the environment which constitutes Mind, yet finds no place in the expression of the nature of Intelligence. Again, that reaction of the organism on the environment which is the outward and visible sign of that adjustment of inner to outer relations which constitutes Intelligence, which is not only the sole outward manifestation of Mind, and our only criterion of the existence of Mind in other organisms, but which also forms a necessary and integral constituent of the correspondence of the organism and the environment, is similarly absent from the expression of Intelligence. Yet without this reaction of the organism on the environment Intelligence could not be said to exist—could not exist as we know it. Hence it appears that whether we look at Mind introspectively, or whether we contemplate it in its objective aspect as correspondence between the organism and the environment, we find that there is something necessarily antecedent to Intelligence, and something necessarily consequent; and that the existence of Intelligence depends on the existence of these factors which bound it, and which must therefore be considered as of an importance at least coordinate with that of Intelligence itself.

Or if we take a third point of view and regard the physiological basis of Mind instead of its internal structure or its outward manifestations, we are conducted to the same conclusion. "Speaking generally," says Mr. Spencer, "feelings and the relations between feelings correspond to nerve-corpuscles and the fibres which connect nerve-corpuscles, or rather to the molecular changes of which nerve-corpuscles are the seats, and the molecular changes transmitted through fibres. The psychical relation between two feelings answers to the physical relation between two disturbed portions of gray matter which are put in such direct or indirect communication that some discharge takes place between them." If this is so, then the physical substratum of thought is a process confined to the interior of the gray matter. It is the establishment of a dynamical connection between two discharging elements. But the physical substratum of feeling is a very different matter. It is the discharge itself. The discharge at the one end of a nerve-path is the physical substratum of one feeling. The discharge at the other end of the nerve-path is the physical substratum of another feeling, and the current from the one position to the other is the physical substratum of a thought. Now the current is fully accounted for by the discharges. A pressure at one position plus or minus the pressure at the other is sufficient, other things being equal, to determine the setting of a current from the one to the other. Here, then, the physical substratum of thought is complete. It needs upon these lines no further elucidation. But with the substratum of feeling it is otherwise. The current along the nerve-fibre cannot set up the discharge in both positions, and may not initiate it in either. Whence, then, comes the one discharge, and whither does the other go? Proximately the one may be set up by discharges coming from other positions, and the other may go to set up similar discharges elsewhere, but ultimately there can be but one source and one outfall for every discharge. Traced to its origin, every discharge of gray matter is set up directly, or with more or less remote indirectness, by currents coming into the gray matter from without—by currents set up by the impact of external forces on the surface of the organism. Traced to its destination, every discharge of gray matter, with which the psychologist is directly concerned, expends itself in producing or altering muscular contraction—in action on the environment, or in modification of such action. And the physical substratum of feeling is a nervous discharge. Hence we are compelled to affirm that every feeling is conditioned either by action of the environment on the organism, or by action of the organism on the environment; and this leads us to the expression of which we are in search. If the foregoing account of the physical substratum of feeling and of the relations of feeling to thought, both when viewed introspectively and when viewed as correspondence, are correct, then it follows that while thought is the establishment of a relation, feeling is the occurrence of a state; and that while thought is the correspondence of a relation in the organism with a relation in the environment, feeling is the correspondence of a state in the organism with an interaction between the organism and its environment.

That the nature of the elementary and allied inferior forms of feeling, which we know as Sensations, is correctly indicated by this expression is tolerably manifest. That the simple states of consciousness which are known as Touch, Temperature, Taste, Smell, Sound, and Colour, are states which correspond with the action on the organism of the several environmental agents that we have learnt to associate with them, does not, I think, need demonstration; and that the simple sensations of effort and resistance are states corresponding with action of the organism on the environment may also be taken as not needing proof; but that a feeling so remote from sensation as the sentiment of Justice is similarly constituted, seems at first sight a very hazardous statement, and that all the highly developed feelings may be similarly expressed will appear to many as extremely improbable.

But if it be denied that the more elaborate feelings, such as Doubt, Honour, Indignation, Patriotism, and so forth, correspond with, and, in so far as their physical conditions are concerned, arise from, an interaction between the organism and its environment, the question at once presents itself, What, then, is their origin? Regard being had to the prevalence of such terms as "Reflective Emotions," "Imaginative Emotions," "Intellectual Feelings," "Ideational Feelings," and similar phrases, it would probably reproduce the prevailing doctrine correctly to say that the higher and more elaborate feelings, such as those instanced, are the results of our intellectual operations—that they arise from the re-arrangement or reconstruction of our ideas. If, then, the higher feelings are compounded of ideas, the elementary components of these feelings must be the elementary components of ideas. However the ideas may be reconstructed or rearranged, the resulting compound can include nothing that was not in the ideas that compose it. Of what are these ideas composed? There can be but one answer, of feelings and cognitions,—that is, of feelings and relations between them. And these feelings again are composed of less complex feelings and of simpler cognitions; and these again of others simpler still. And so we may pursue the analysis through successive stages of diminishing complexity until we come to feelings so simple as to be undecomposable and to relations between them—relations that disappear when the feelings disappear between which they subsist—so that the analysis of the highest feelings discloses that their ultimate elements are feelings of the simplest order; and these simplest feelings—primary undecomposable sensations—are the states which unquestionably correspond with direct interactions between the organism and its environment. Hence it follows that the highest feelings at length attained by the compounding and recompounding of these simplest feelings, however complex they may at length become, and however far removed they may be in the order of evolution from the lowest, must yet retain the fundamental qualities of the units by whose combination they have been formed, and must therefore result in the last resort from interactions between the organism and the environment. It is true that the elementary feeling of colour cannot be recognised *primâ facie* as a component of the complex feeling of Justice; but neither can the elementary solid carbon be recognised *primâ facie* as a component of the complex fluid alcohol, yet no one doubts that the carbon is there. The difference between the sensation of colour and the sentiment of Justice is not wider than the difference between the black, heavy, refractory, tasteless, odourless, solid carbon, and the transparent, light, mobile, pungent, liquid alcohol. And as it is certain that the carbon retains in its combination in alcohol the same fundamental properties—the specific heat, the molecular weight, and the combining proportion—that it possesses in the free state, so it is certain that whatever elementary visual feelings enter into the formation of the sentiment of Justice, retain in combination their fundamental quality of corresponding with an interaction between the organism and the environment. If there are any who think that the comparison between material and mental compounds is vitiated by the greater ease with which the components of our own mental states can be identified, I would remind them that so relatively simple an analysis as that of our ideas of visible form into feelings of colour and feelings of movement, was not effected until Mind had been systematically studied by generations of profound thinkers, for a period of two thousand years.

While it is true that every complex feeling is compounded of the simplest feelings, and so depends for its existence ultimately on the corresponding interactions between the organism and the environment, yet this is only a part, and a subordinate part of the truth. According to the doctrine here proposed, the complex feelings not only have their distant rootlets derived from interactions of the simplest character, but each such feeling is itself the state which corresponds with and is aroused by some similarly complex interaction between the organism and its environment. Every feeling is therefore connected with action in two ways—longitudinally in its origin, and transversely in its occasion.

If this statement of the nature of feeling is correct, and if Feeling, like Intelligence, is a feature in or a factor of the correspondence between the organism and the environment, then each elevation of feeling, like each advance of Intelligence, must be an extension of the correspondence. Mr. Spencer has shown in detail how each advance of Intelligence is an extension of the correspondence in Time, in Space, in Speciality, in Generality, in Complexity, etc.; and if Feeling also is expressible in terms of the correspondence, then every advance in Feeling must be an extension of the correspondence in Time or in Space, or in some other mode, or in several modes combined. If it were possible to treat in detail this aspect of the correspondence in the same way that Mr. Spencer has treated the aspect that constitutes Intelligence, the correctness of this expression of the nature of Feeling might be regarded as proved; but such detailed and complete treatment is from the nature of the case impossible. Something indeed can be done on the same lines as Mr. Spencer's treatment of Intelligence, but anything approaching the elaborateness of his argument or the conclusiveness of his results is impracticable, as will be seen when the obstacles have been enumerated.

The first difficulty that we have to contend with is that arising from the defectiveness of our terminology, an obstacle of great consequence in dealing with subject-matter of so high a degree of abstractness. In such dealings words and names assume a degree of importance far beyond that which attaches to them as symbols for concrete things. In the latter case they are merely a kind of short-hand expression for the group of known qualities of the thing—qualities that can be dealt with in thought apart from the name; which is a mere excrescence or appendage to them. But in the former the name is often the most definite and tangible attribute of the thing, whose other attributes gravitate as a misty and fluctuating nebula round the nucleus formed by the name. Hence when, as often happens, a feeling or a group of feelings has no name, not only are we compelled to embody it in some unwieldy phrase, but its very existence is apt to remain unrecognised. Such feelings are "the sentiment of power possessed and exercised" (Bain), "the feeling of fulfilled ambition." The feeling of high spirits—of that general exaltation of consciousness a high degree of spontaneous activity—has no more definite appellation. Mr. S. H. Hodgson speaks of a feeling of

" admiration of externals " which has no less extended title. Many shades of feeling are often included in a single name, as not only friendliness and sexual and parental love under the head of Tender Emotion, which are separate and separately named species under a single genus, but under the term Love, understood in its ordinary sense, as affection between the sexes, an almost infinite number of grades are included. Underlying all its varieties there is the fundamental substructure of physiological craving, just as underlying every landscape there is the bare earth; but just as in some landscapes there is nought but bare or lichen-covered rock, so in some natures there is little or nothing besides this craving. In other natures this substructure is covered and hidden by a luxuriant growth of higher forms of feeling—the appreciation of beauty, admiration, emulation, self-esteem, self-devotion, the desire for, or the fulfilled gratification of, sympathy, of confidence, of being highly appreciated; pride, vanity, possession, power and many others. So that, although these feelings are all massed and consolidated into one grand Emotion, and may properly be considered as a single complex feeling, yet this feeling so constituted cannot be considered a feeling of the same evolutionary grade as the simple physiological craving, any more than the tropical luxuriance of a Brazilian forest can be considered to exhibit the same grade of landscape as the lichen-covered rocks of Spitzbergen, because the same underlying terrestrial crust makes both of them possible. Looking at the two feelings from the point of evolution, the one is primitive, simple, undeveloped; the other highly complex, derivative, and compound. They are at opposite ends of the evolutionary scale, and yet the same name passes current for both. Phases of conduct such as Slyness, Cruelty, Craft, Ridicule, Sarcasm, etc., have been erroneously termed feelings, as likewise have certain cognitions, such as those of symmetry and order, and certain acts of agents in the environment as Rhythm.

Passing from single feelings to groups of feelings, the same difficulties beset us in an exaggerated form. Several well-characterised groups of feelings have no generic name, although the individual feelings composing the groups have each their specific title. Thus we have the feelings of Prudence, Caution, the "instinct of Self-Preservation," etc., but no name for the whole group of feelings which correspond with acts relating to future security. We have names for the several feelings of Doubt, Belief, Conviction, Scepticism, Perplexity and Disbelief, but none for the well-characterised group that they constitute.

Difficulties such as these are only on the threshold of the subject. They concern only our means of dealing with it, and are removable by the perfection of those means—by the industrious pursuit and elaboration of the descriptive or Natural History side of the study. But there is another and much graver class of obstacles that are inherent in the subject itself, and that no amount of effort can remove. These we have now to consider.

In nothing is the difference between Intelligence and Feeling wider or more sharply accentuated than in their external manifestations. Intelligence can be directly inferred from acts. What is internally an increase of intelligence is outwardly an increased nicety of adaptation to external circumstances—a capability to perform more elaborate and better adjusted actions. Conversely, from the observance of acts we can directly infer the possession of a degree of intelligence corresponding with the delicacy, complexity, elaborateness, etc., of the act observed. We can take Conduct and posit it as Intelligence or as the manifestation of Intelligence, and infer directly from the one to the other. But in the case of Feeling we cannot do this. In dealing with Intelligence, it is possible to ignore in great measure the introspective aspect. In the previous Part it has been shown that we can regard Intelligence in its outward manifestations alone from several points of view; positing conduct as intelligence, and regarding each adjustment of the organism to its environment as an instance of intelligence—of intelligent action. But although we call elaborate conduct intelligent, we do not necessarily imply that such conduct is accompanied by consciousness. Nay, we have great reason to believe that conduct may be extremely elaborate, and yet consciousness be rudimentary or altogether absent. The combined action of many social insects, all subserving a common end, and sometimes reaching an astonishing degree of complexity, are not held to imply a correspondingly complex train of thought in the insects. In certain morbid states in man, actions of most complicated character are executed, without, as far as we are able to ascertain, any consciousness at all. Yet we regard the action as intelligent in proportion to its novelty, to its complexity, and to its prudence, without regard to the amount of consciousness that may have accompanied it. So regarded, the estimation of intelligence is a purely physical science, and may be conducted on the methods of other physical sciences. But with Feeling the case is very different; for the term Feeling necessarily connotes consciousness. From conduct we can indeed infer feeling, but we cannot infer it with the directness, the certainty, the unhesitatingness that we infer intelligence. We cannot take conduct and posit it as feeling. It must first be translated, and the process of translation is liable to many and serious errors. It is true that Lewes speaks of unconscious feeling, but such a phrase is to most people contradictory and meaningless, and it is certainly a straining of the ordinary use of words, and a phrase that has never gained acceptance. Nevertheless, in order to show that elevation of feeling is an advance of the correspondence between the organism and the environment, it will be necessary to make this translation, and to run the risk of the errors so introduced. That the Feeling that we call green or greenness is the same in A, B, and C, who speak of it in the same manner, and whose other acts in regard to green objects are similar, we may well believe; but we have no proof, and for aught we know, the feelings so designated may be very different in these different people. In the case of D, who is colour-blind, we know that the feeling of green is either absent, or is very unlike the feeling so designated by A, B, and C. If this be so in individuals of the same species, the same race, the same family, individuals who may be very nearly related indeed, what vestige of validity is there in a comparison between feelings of colour that are experienced through the simple eye of man, and those experienced through the compound and multiple eyes of insects? How is it possible to argue from the sense of touch in man to the corresponding sense in a rhinoceros, a lobster, or a sea-urchin? If we see a snake turn and bite the foot that has trodden on it, are we to suppose that the snake feels anger? And if we do make this bold supposition, is it not certain that the feeling so designated must be very different from the feeling of anger with which a man regards one who has injured him? Are we to call the feeling that prompts the crab to pinch anger? or the feeling in the centipede that bites, or in the jelly-fish that stings? Mr. Spencer has compared the tactual feelings of a lobster to those that we might experience by poking about with walking-sticks; but how are we in the other direction to compare our feelings of touch with those of the bat, which can avoid the most trifling obstacles when blinded, by the varying impact of the aerial waves upon the delicate expanse of its wings? or our dull sense of smell with that of the bloodhound, that will trace the course of one man through a crowded street hours after he has passed by discriminating his scent from that of all the rest? Whatever feelings these animals may have, the only thing that we can safely predicate of them, is that they must of necessity be widely, and in many cases utterly, unlike our own. The difficulty of inferring feeling from conduct, great in the case of sensation, is far greater in the case of the higher feelings. It would be preposterous to say that the termites that fight desperately to keep other tribes out of their territory are animated by patriotism, or that the ants that sacrifice their lives for the pupæ feel the glow of heroism, or that the stickleback that nurses his spawn feels the joys of paternity, or that the spider that drags her bag of eggs about with her has any feeling of maternal fondness. To attribute to these animals, on account of such actions, feelings like our own would be not only a gratuitous and groundless assumption, but would be on the current supposition demonstrably false. For if feeling is the subjective side of what is objectively a nervous process, then for similar feelings to be experienced the nervous process must be similar. And a similar process can take place only in a similar structure, and the nervous systems of man and of invertebrates are not similar.

Relations, again, are of few orders — coexistence, co-extension, simultaneity, connature, and their opposites — and not only is every relation comparable with every other of the same order, whatever differences may exist among the terms, but, since all can be reduced to the common terms of likeness and unlikeness, relations of different orders can be compared *inter se;* and by collating examples from every variety of relations, it becomes easy to form a series which shall exhibit every gradation of speciality, complexity, etc., as the correspondence advances. But in the case of feelings this elaborate comparison is impracticable. Feelings of the same order are neither sufficiently numerous nor sufficiently diverse to afford materials for an extended comparison of their degrees of elevation, and feelings of different orders do not admit of any but the most imperfect comparison *inter se.* The feelings of Touch, which arise in correspondence with a mechanical action taking place upon the surface of the organism, do not admit of an extension of this correspondence in space, in the sense of an increase of the distance between the organism and the agent. Feelings of colour are indeed numerous, but the interactions with which they correspond have no wide differentiation, and the feelings exhibit no marked grades in elevation. The feelings of Disgust admit of many grades of intensity and volume, but not of difference as to their elaborateness or value in the evolutionary scale. To the emotions of Gratitude, of Anger, of Grief, of Ease, of Annoyance, and many others, the same statement applies. When we seek to eke out these infrequent opportunities of comparison by collating feelings of different orders, we do not get much help. It is easy to see that Anger is a more elaborate feeling than Touch, and that Duty is a more highly developed feeling than Anger, but when we compare states that are divided by intervals less vast than these, the difficulty of deciding on the relative rank of feelings is often extreme. The feeling aroused by the view of a beautiful landscape may be to some extent compared with that aroused by a beautiful sonata, and may be pronounced of approximate equality; but between a feeling of Perplexity and one of Indignation, or between the feeling which is aroused by witnessing an act of bravery and that which is evoked by the loss of a friend, no definite comparison can be drawn, far less can an estimate of their relative grades of elevation be made with any approach to accuracy. Not only are relations of comparatively few orders, and where of different orders reducible to common terms, thereby allowing of easy comparison, but the number of individual relations is virtually infinite, and their individuality is clearly defined, thus allowing the progress of the correspondence to be traced by almost infinitesimal gradations. Feelings, on the other hand, are comparatively few in number, are so widely different in character as to be in most cases scarcely at all comparable, and admit of but vague limitation.

A source of confusion which, though tolerably obvious, may easily be dropped out of sight, is the prevalent use of the phrase, "elevation of feeling," in an ethical sense—a sense widely different of course from that in which it is used here. The height of development of a feeling, or its grade in the evolutionary scale, is of course a quality quite different and apart from its ethical grade or its elevation in the scale of morality. Doubtless some of the higher ethical feelings, such as that known as a "nice sense of honour," or the feeling of devotion to a cause, occupy a very high place in the evolutionary scale also; but ethical feelings of great purity and intensity—feelings that would rank high in any ethical scale—are possessed by men of extremely primitive type, and even by animals. Dogs, for instance, have unquestionably a feeling of Duty, and in many animals parental love reaches such intensity as to prompt to actual self-immolation. On the other hand, there are feelings, such as Sublimity and Scepticism, that are very high in the evolutionary scale, feelings of which only highly developed natures are capable, yet which have no ethical value whatever ; and there are others, such as Revenge, which imply the attainment of a certain complexity of development, and yet from an ethical point of view are actually minus quantities.

Another source of confusion lies in the fact that the intensity and volume of a feeling, while they are no criterion of the grade of that feeling as compared with other feelings experienced by the same individual, yet may speak strongly as to the height of development reached by the individual by whom the feeling is displayed. For the most recently acquired feelings are, like all recently acquired qualities, less deeply organised, less easily evoked, and less pronounced in their manifestations than the older qualities ; and individuals may be safely estimated to have attained a grade of development that is high or low, according to the grade of those qualities that are in them most preponderantly developed.

Lastly, the gravest difficulty of all is that we have no standard by which we can gauge the grade of feeling. It is true that in the case of Intelligence no formal standard exists, but the ease with which intellectual operations can be compared with one another renders a standard unnecessary. Unless the difference between them is very slight little dispute is likely to arise as to which of two acts is the more intellectual. When we speak of the "advance of Intelligence" a fairly definite concept is given and received. We may not be able to formulate in more exact terms the meaning that we attach to the expression, but this is mainly because the expression is already in its simplest and most intelligible form ; and if no more definite expression is possible, neither is any needed. But Feeling is so much less definite a matter, is limited so much less precisely, is so much less capable of exact treatment, has been so much less thoroughly investigated, our knowledge of it is altogether in such an inchoate condition, that to speak of the "advance of Feeling" arouses no such definite concept, and needs some explanation before it will be understood by all in the same sense. By the advance, or elevation, or extension of Feeling is here meant its elevation in the evolutionary scale,—that is to say, its gradual emergence from indefinite, incoherent homogeneity to definite coherent heterogeneity; or in terms less precise, but perhaps more generally intelligible, its increase in elaborateness and complexity.

To sum up the difficulties that militate against a treatment of Feeling similar to Mr. Spencer's treatment of Intelligence. We are hampered by the defectiveness of our terminology and by the imperfect state of the Natural History or descriptive portion of the subject—by the inclusion of many different feelings under the same name, and by the absence of any received title for many well characterised feelings and groups of feelings. Feelings, so far from being, as relations are, virtually infinite in number, and fairly definite and well-characterised in nature, are comparatively few, and have but a vague characterisation. Relations of all orders are comparable *inter se* by reduction to the common terms of likeness and unlikeness; while Feelings of different orders are not reducible to common terms, and do not admit of definite comparison. Intelligence is inferrible from acts directly and with certainty. Feeling can be inferred from acts often by an indirect and circuitous course, and with considerable doubt. While the advance of Intelligence is unambiguous, and conveys to every one a clear concept of the process indicated, the corresponding expression "advance of Feeling" is extremely apt to carry an ethical connotation which is neither intended nor desired. Lastly, while every one possesses a moderately definite standard by which he can judge of intellectual operations as more or less elevated in degree of intellectuality, in the case of feeling no such standard exists.

Consideration of all these obstacles brings out clearly the inherent impossibility of carrying out a detailed exposition of Feeling as correspondence with any approach to the completeness of Mr. Spencer's masterly handling of the similar aspect of Intelligence. Nevertheless, wherever there exists a series of interactions sufficiently similar to be comparable, these feelings can be shown to exhibit grades in parallelism with those of the interactions. The truth of this statement will be apparent in the course of the following chapters.

CHAPTER XII

CLASSIFICATION OF FEELINGS

Of the various methods of classifying the Feelings that have from time to time been proposed, the majority were originated while the science of psychology was as yet without form and void, and, being therefore out of harmony with the discoveries and developments since attained, they may for the present purpose be disregarded. Recent as is the philosophical work of Sir W. Hamilton, his outline of a classification is wholly obsolete, not more, however, from the advance that has since taken place in our knowledge than from the slight elaboration that he bestowed upon it. Crude as it is, however, his system is remarkable, and in my opinion chiefly meritorious, for the recognition, vague indeed and rather implied than expressed, of the necessity of taking account of circumstances external to the organism in defining and estimating the feelings. Subsequent attempts at classification, including that of Waitz, the intricate and minutely elaborated system of Wundt, and even the more recent effort of Mr. Shadworth H. Hodgson, all appear to me so wanting in the first and most elementary condition of a classification—the condition, namely, that the groups shall mutually exclude one another—as to carry within themselves their own condemnation.

Adopting, as I do, Mr. H. Spencer's *Principles of Psychology* as a profound and masterly exposition of the origin and nature of the normal mind, I must yet dissent from his classification of feelings, on the same ground as I dissented from his similarly founded classification of cognitions; and in the former case my disagreement with Mr. Spencer is much more complete and thorough than in the latter. In the classification of cognitions, while dividing the primary groups upon another principle, I was able to accept the degree of representativeness as demarcating the secondary groups from one another; but in the case of the feelings, this principle appears to me altogether inappropriate as a basis of classifying even the minor clusters. Without denying that the classification of feelings according to their degree of representativeness indicates in a vague and general manner certain real differences of composition, it yet appears to me, not only that the arrangement so made is too vague to be of any real service—not only that it fails to discriminate between widely-unlike feelings and fails to group together feelings that are closely allied—but that it is founded on a basis which totally ignores a fundamental principle of Mr. Spencer's own system of psychology. That the principle of representativeness permeates every feeling and varies in each class of feelings, I freely admit; but it does not therefore follow that it forms an adequate basis for classification, any more than it follows that the variations in character of the vessels of a tree form an adequate basis of classifying its parts, because they permeate throughout and vary in each part. That Mr. Spencer's groups "are but indefinitely distinguishable" he candidly admits, and this indefiniteness would by no means of itself invalidate his arrangement, if it could be shown that the things he classifies are correspondingly indefinite in their limitation. But are they? Is the feeling of Anger so indefinitely distinguishable from the feeling of Love; the feeling of Terror so indefinitely distinguishable from the feeling of Triumph; the feeling of Blueness from that of Warmth; the feeling of Beauty from that of Indignation;—that they must all be accumulated together within the same class, and no attempt be made to regroup them in minor clusters within the class? So startling a result may well arouse suspicion that Mr. Spencer's classification is invalid—a suspicion which develops into assurance when the investigation is pressed home, and when the consequences and implications are brought out in detail. The classification proposed by Mr. Spencer (ii. 514) is as follows :—

"*Presentative feelings,* ordinarily called sensations, are those mental states in which, instead of regarding a corporeal impression as of this or that kind, or as located here or there, we contemplate it in itself as pleasure or pain : as when inhaling a perfume.

"*Presentative-representative feelings,* embracing a great part of what we commonly call emotions, are those in which a sensation, or group of sensations, or group of sensations and ideas, arouses a vast aggregation of represented sensations ; partly of individual experience, but chiefly deeper than individual experience, and, consequently, indefinite. The emotion of terror may serve as an example. Along with certain impressions made on the eyes or ears, or both, are recalled into consciousness many of the pains to which such impressions have before been the antecedents; and when the relation between such impressions and such pains has been habitual in the race, the definite ideas of the pains which individual experience has given, are accompanied by the indefinite pains that result from inherited experience—vague feelings which we may call organic representations.

"*Representative feelings,* comprehending the ideas of the feelings above classed, when they are called up apart from the appropriate external excitements. The feelings so represented may either be simple ones of the kinds first named, as tastes, colours, sounds, etc. ; or they may be involved ones of the kinds last named. Instances of these are the feelings with which the descriptive poet writes, and which are aroused in the minds of his readers."

So that, according to this classification, feelings so different as those of Anger, Love, Beauty, Contempt, Perplexity, and Fear — all of them feelings "in which a sensation or group of sensations, or group of sensations and ideas, arouses a vast aggregation of represented sensations"—

belong to the same class—that of Presentative-representative feelings. Feelings so different as Blueness, Triumph, Saltness, Hatred and Hardness, if remembered, and not called up by any appropriate external excitement, belong to the same class—that of Representative feelings. But a feeling of Anger arising in the presence of a detested person, and the same feeling arising from the remembrance of him, are classed in separate groups—the one is a Representative feeling, the other is Presentative-representative.

Mr. Spencer finally includes under the head of

"*Re-representative feelings* . . . those more complex sentient states that are less the direct results of external excitements than the indirect or reflex results of them. The love of property is a feeling of this kind. It is awakened not by the presence of any special object, but by ownable objects at large; and it is not from the mere presence of such objects, but from a certain ideal relation to them, that it arises. It consists, not of the represented advantages of possessing this or that, but of the represented advantages of possession in general—is not made up of certain concrete representations, but of the abstracts of many concrete representations; and so is re-representative."

This group is then a higher group than any of the preceding, and includes feelings of a different class, excluding of course the feelings belonging to the groups below. But the description that Mr. Spencer gives of the constitution of these feelings is exactly applicable to some at least of the feelings in the inferior classes. To guard against any possibility of misrepresenting Mr. Spencer, I will take his own example of the Presentative-representative class—the emotion of Terror—and ask if his description of a Re-representative emotion is not strictly applicable to it.

When a child enters a dark room alone, is it not a fact that the terror which it feels is "awakened not by the presence of any special object but by terrifying objects at large?" Is it not true that "it is not from the mere presence of such objects, but from a certain ideal relation [of accessibility] to them that" the terror arises? Does not the terror consist, not of the represented injury inflicted by this or that, but of the represented feelings of injury in general; is it not made up, not of certain concrete representations, but of the abstracts of many concrete representations; and is it not so re-representative? If this is a true description of the constitution of the feeling of terror, and it is difficult to perceive a flaw in it, what becomes of the distinction drawn by Mr. Spencer between feelings of the presentative-representative class, and those which are re-representative? And if, on the other hand, it is not a correct description, yet it must be acknowledged to be so close an approximation, that a classification whose primary groups are divided by such subtle differences is for practical purposes unworkable. While, therefore, as already admitted, the principle of representation, in common with the quality of pleasure or pain, does no doubt indicate an actual element which pervades every class of feeling and varies in each, yet the classification founded on it fails at every point at which it is brought to the test; and this collapse of the classification is sufficient proof of the inadequacy of the principle on which it is founded.

The impracticable character of Mr. Spencer's classification of feelings seems to me, however, to be the most cogent evidence of the truth and of the value of his system of psychology; for it demonstrates that when that system is departed from, not even Mr. Spencer himself can succeed in constructing a stable edifice on any other foundation. The classification that he has raised with such care is built upon sand, and falls to pieces before the first gust of criticism. It is true that his classification of feelings, unlike his classification of cognitions, is not opposed to any definite statement that he has made with regard to them; but this is because he gives no direct exposition of the nature of feeling. He does not specifically state of Feeling, as he states of Intelligence, that it is a feature in, or a portion of, the correspondence between the organism and its environment. He does, however, allege that "the several grades of mind and its component faculties are phases in the correspondence and factors of the correspondence," and again he speaks of "all mental phenomena" as incidents in the correspondence—expressions which must be held to include feelings. Apart, however, from any formal admission, no one who is familiar with Mr. Spencer's *Principles of Psychology* can doubt for a moment that Feeling as well as Intelligence is to be considered as "a phase in, or a factor of, the correspondence" between the organism and its environment. If Feeling and Thought grow from a common root and are inseparably involved, as Mr. Spencer shows them to be; and if in their development they become more and more closely interconnected, until at last they are well-nigh indistinguishable, as may be maintained; and if Intelligence, one of these two co-ordinate factors, is expressible in terms of the correspondence between the organism and its environment, then Feeling, the other co-ordinate factor, *must* be similarly expressible. If Life in general, and if Mental Life in particular, can be expressed in terms of the correspondence, then, since the whole includes the part, each and every factor of Mental Life can be so expressed. That one such factor can be so expressed, Mr. Spencer argues at great length and with irresistible force. That the other factor can be similarly expressed is my contention.

Mr. Spencer's treatment of this subject is the more remarkable, since Professor Bain had already published an arrangement of feelings, in which, without any acceptance of Mr. Spencer's views, he yet formally takes account of external circumstances, not indeed in a definition or enunciation of feeling, but as determining the arrangement of feelings. So that we have this remarkable state of things —that Mr. Spencer, the chief exponent of a Realism, which, if "transfigured," is rather more than less stringent and widely applicable than the old Realism, classifies feelings from a standpoint mainly subjective, while Professor Bain, who repudiates Mr. Spencer's system, is driven by stress of logical emergency to adopt in practice his fundamental principle, and to arrange the feelings with reference to the external circumstances with which they correspond.

While the merit of abandoning the subjective standpoint, and of classifying the feelings with some reference to external circumstances, belongs unquestionably to Professor Bain, yet he admits these circumstances not so much as a fundamental factor of classification as for incidental and collateral purposes, and his classification makes no attempt at detailed completeness. With his customary philosophical candour, Professor Bain admits the imperfection of his arrangement, and goes on to express the opinion that the difficulty of expounding the Emotions in a strict order of sequence is permanent and insuperable. "Begin where we will," he says, "as we can only take one source at a time, we must anticipate what is to follow. The only thing to be done is to recognise the fact, and also its consequence, namely, that there is no one absolutely preferable arrangement." In so far as this conclusion refers to an arrangement in serial order, it is no doubt necessary and inevitable. But what is the obvious implication? That since a serial arrangement is impossible, therefore no arrangement is possible? Surely not. Two generations ago the same permanent and insuperable difficulty was experienced by the botanists and by the zoologists of that day, in the serial arrangement of vegetable and animal forms. So long as they stood still and kicked against the pricks, so long did science stand still with them, and when the impracticable character of such an arrangement was recognised and admitted, the first step was taken in the circumvention of the difficulty and towards a classification, non-serial indeed, but based upon fundamental likeness and differences, and in accordance with genealogical affinities. And similarly we may hope, nay, we may sanguinely expect, that the recognition, thus formally declared by Professor Bain, of the impossibility of arranging the feelings in linear sequence, heralds the abandonment of all attempt at such an arrangement, and the construction of a classification according to those fundamental properties which they have acquired from the source and in the process of their development. That such a classification alone can express the true relations of the feelings to one another is demonstrated by reason and enforced by analogy; and that our knowledge is ripe for the attempt is sufficiently indicated by Professor Bain's declaration.

From what has been said it will be already apparent that the classification of feelings that is here proposed is founded not on any distinctions between the qualities of feelings as subjectively viewed—an aspect to which belong such distinctions as those between Appetites, Desires, and Affections (Reid); as that between the Subsidiary Faculties and the Elaborative Faculty (Sir W. Hamilton); that between Sensual Feeling and Intellectual Feeling (Kant); that between Harmony and Conflict (Herbart); that between Formal Feelings and Qualitative Feelings (Waitz); those between Affections, Moods, and Passions (Wundt); those between Direct, Reflective, and Imaginative Emotions (Hodgson); and, it may be added, that between Representative and Re-representative Feelings;—but is based, like the classification of Cognitions previously proposed, on variations of the correspondence between the organism and its environment; of which correspondence Feeling is a cardinal factor.

The term Feeling, like the term Cognition and several other terms used in psychology, is used in two distinct senses. It is used to express a process, and also to express the result of that process. Just as Cognition may mean either the process or act of cognising, or the state of mind remaining on the completion of this act, so may Feeling be understood either as the process of feeling or the state of mind resulting from the process. It is in the latter sense that the term will be most used here, and the context will show clearly when the other meaning is implied.

Expressed in terms of the correspondence, the process of Feeling is the correspondence of states in the organism with interactions between the organism and the environment; and the states so corresponding are the individual Feelings. If Feeling is the state in the organism which corresponds with an interaction between the organism and the environment, then Feeling must vary as this interaction varies, and it must be possible to obtain a classification of feelings from a classification of the actions.

If we take this principle as a basis of classification and apply it to Feeling as a whole, planes of cleavage start to view, separating the mass into divisions and subdivisions that appear so coherent internally, and so clearly demarcated externally, as to present a strong *primâ facie* claim for consideration.

Now, what is the most fundamental division that can be made among interactions in general, as occurring between two agents? Manifestly that according to the way they are begun. Such an action may be begun by one agent, or by the other, or by both together; and manifestly the way in which it was begun will affect and modify the whole of the remainder of the action. An interaction between the organism and the environment may be initiated by the environment, or by the organism, or simultaneously by both, and the corresponding feelings will fall naturally into three great orders. Feelings of the first order have their root in the sensation of Touch, and its extension Pressure, which corresponds with the most fundamental action of the environment on the organism—the action of mechanical contact. Feelings of the second order have their root in the sensation of Effort, which corresponds with muscular movement—the fundamental form of all actions of the organism on the environment. Feelings of the third order have their root in Resistance, which is manifestly a combination of the other two. While therefore this feeling, as it partakes of the nature of the other two, approaches nearer to both of them than either of them does to the other, yet, inasmuch as it is compound, it differs more widely from them both than they do from each other. What is the nature of this difference? A feeling of Touch and a feeling of Effort do not necessarily combine into a feeling of Resistance when experienced together, as may be seen when the touch refers to one part of the organism and the effort to another.

What then is it that the sensation of Resistance corresponds with? It is the *relation* that the two factors in the interaction bear to one another—the relation of the muscular strain to the pressure, or, in subjective terms, the sensation of Resistance is the relation of the sensation of Effort to that of Touch or Pressure. But a relation between two feelings is a cognition. Ought we not then to speak of Resistance not as a feeling but as a cognition, seeing that it is a relation between feelings, and corresponds with a relation —that of coexistence between extension and body—in the environment? Whether we so regard it depends entirely upon the aspect from which we look at it. Undoubtedly the state of mind called Resistance is a relation between two feelings, and is therefore, from one aspect, a cognition; but, as Mr. Spencer points out with great clearness, a relation between feelings *is itself a kind of feeling*—the momentary feeling accompanying the transition from one conspicuous feeling to an adjacent conspicuous feeling, and therefore imperatively demands a place in a classification of feelings. The fact that the scheme here set forth necessitates an inclusion of cognitions in the classification of the feelings, so far from militating against it, is actually evidence in its favour. The great difference between feelings, and relations between feelings when subjectively viewed, is the duration; and I have already shown how, as cognitions become more and more complex, they become more prolonged, so that while every cognition is in one aspect a feeling, this aspect becomes more and more conspicuous as cognition becomes developed. Hence there is the more reason for indicating the position that such feelings occupy at the root of the classification.

The way in which an interaction is initiated, as it is a necessary element in all interactions whatever, is *a fortiori* a necessary element in all interactions between the organism and its environment; and every group of interactions that is constituted on any other principle must necessarily be susceptible of division according to the way it is begun. There is, however, a set of divisions of very different character, which, although they are applicable only to the special group of interactions with which we are now concerned—those between the organism and its environment—are based on a principle that, in reference to these interactions, is of primary importance. They are based on the principle of Evolution.

To announce to a botanist or a zoologist that the classification of plants or of animals ought to conform to their genealogical kinships, and therefore to harmonise with and illustrate the principle of Evolution, would be as idle and superfluous as to persuade an astronomer of the truth of the law of Gravitation. The matter has passed out of the region of discussion. It has become an accepted doctrine—a truism. The great majority of modern psychologists admit that the human organism has come into existence and reached its present condition by a similar process of evolution, and that by this process has originated and developed not only the physical organism but the mind also. Those who admit the development of mind by evolution, should therefore not need, any more than the botanist or the zoologist, a laboured demonstration that the states resulting from this process should be classified in accordance with it. For those who do not admit that the principle of evolution applies to mental phenomena, this paper is not intended. It does not appeal to them; it has no claim to their consideration. But those who do admit the application of evolution to this region of being are committed beforehand to an approval of the basis of my classification. That the details or even the grosser structure are correctly worked out is not claimed, is perhaps not even probable; but it is claimed that evolutionists are logically bound to accept the principle of the classification, and that the burden of disproof lies with those who reject it.

In the classification of animals and plants, the primary divisions are marked out by differences in some fundamental attribute—by the mode of germination in the one case, and by the presence or absence of organs of profound importance, as limbs, blood-vessels and nervous system, in the other. The division of the primary into secondary groups follows the variation of some attribute of the primary group that is not only of secondary importance, but is, or may be wholly wanting in the other primary groups. The phanerogamic plants, for instance, are divided according as their seed possesses one or more cotyledons—organs that have no existence outside this group. The dicotyledonous plants are classified according to the number of their petals—organs that no other kind of plants possess. The sub-orders of the leguminosæ are determined by variations in the characters of the pod—a form of fruit that is confined to this order. And the classification of animals proceeds in the same way. The inference is obvious. If the feelings have come into existence by the same process of evolution to which plants and animals owe their origin, and if the classification of the latter, following the lines of this process, exhibits certain characters, then it may be expected that the classification of the former, following the same process, will exhibit similar characters. When it is found that the mode of classifying the feelings that is here proposed does exhibit a well-marked similarity to the accepted mode of classifying animals and plants, it may be claimed as an additional indication that the principle on which it is founded is correct.

It may be objected that we have now got two principles of classification, one according to the way the interaction is begun, the other according to its position in the evolutionary scale, and that these two principles are so widely different that the lines of division that they regulate cannot possibly coincide with or even approximate to each other; and this must be admitted, but it does not invalidate the classification. A classification which follows the course of evolution is often and very aptly compared to the structure of a tree. It may be said that a tree forms a solid diagram of such a classification—a diagram in three dimensions. The most general and least differentiated forms are represented by the stem of the tree, and the more elaborate and special forms by the successively diminishing branches. Such a diagram represents accurately the classification of feelings according to the principle of evolution. The other principle of division—that according to the way in which the action is begun

—runs, as I have said, through every branch of feeling that is constituted on any other principle, but it does not necessarily destroy the other mode of classification. It may be represented on our diagram by the difference between the bark and the wood—a difference that is perceptible no less in the extremest branches than in the trunk, a difference that permeates throughout and yet leaves the other method of division absolutely unaffected. The analogy may be stretched much further without breaking. For just as the arborescent form is peculiar to the tree, so the division of interactions according to the principle of evolution is peculiar to the interactions between organisms and their environments; and as the division between cortex and interior is common to the tree and all other bodies that are acted on from without, so the division between interactions that are internally initiated and those that are externally initiated is common to all interactions whatever. The parallel may be carried even further. The description of the tree is not completed by the consideration of the parts that are above ground only. There yet remains the root, a part that ramifies in a different direction and in a different manner, and is not open to direct observation. Similarly there is a body of feelings—those constituting the Cœnæsthesis, or the Visceral or Organic Sensations—which correspond with interactions occurring within the organism, and these interactions are not open to direct observation, are connected with the other interactions and are yet distinct from them, and are divisible upon a different method.

There is yet a third general principle in accordance with which feelings may be divided. This is the directness or indirectness of their correspondence with interaction, and, in the latter case, the degree of remoteness from direct correspondence. Feelings which correspond directly with an interaction between the organism and its environment are termed Sensations; those which correspond indirectly are termed Emotions; and when the remoteness from direct correspondence is great, the feeling is in some cases termed a Sentiment. When the correspondence is indirect it would usually be correct to say that the feeling corresponds with a *relation* between the organism and the environment, and this mode of expression will often be used hereafter, but it must be borne in mind that the relation is always a relation of interaction, past, future, or possible, and that it is this element of activity that alone arouses feeling. The feelings of cognition, for instance, which have already been referred to, may properly be regarded as the state in the organism which corresponds with the relation between two such interactions.

Considered in the light of the principle of Evolution, there are two classes of interactions between the organism and the environment which stand out pre-eminently before all others in their importance and in their antiquity. These are the interactions which primarily affect the conservation of the organism, and those which primarily affect the perpetuation of the race. Of course every interaction between the organism and the environment must necessarily affect to some extent, however slightly, its conservation, and must affect in some degree, however remote, its ability or tendency to perpetuate the race; but we speak here of interactions only as they primarily subserve or oppose these two great ends. Compared with the interactions that affect these two great and primordial ends all others are but of yesterday, although even the following group dates from a period long prior to that at which the race attained to the dignity of humanity. There is little doubt that, long before our ancestors had reached the organisation and status of Man, they lived gregariously, so that for a period which may not include a large section of the whole life of the race, but which is intrinsically very great, each individual organism has been subject as a member of a community, to a number of interactions affecting the common welfare, of which some are concerned with the environment of the community, and others are concerned with the community itself, regarded as a special (the social) environment of the individual. From interactions that concern the welfare of the organism in common with that of other individuals to those that concern other individuals only is not a long step; and through this class of interactions we pass to those that are neither conservative nor destructive, a somewhat heterogeneous group, comprising all the residue of interactions that are not included in previous classes. Finally, there is a class of feelings—the feelings of Cognition—which correspond with a relation between interactions. Classed upon this method, the main groups of feeling will therefore be six in number, corresponding with the main classes of interactions with the environment of which the organism is capable, viz.:—

CLASS I. Those which primarily affect the conservation of the organism;
CLASS II. Those which primarily affect the perpetuation of the race;
CLASS III. Those which primarily affect the common welfare;
CLASS IV. Those which primarily affect the welfare of others;
CLASS V. Those which are neither conservative nor destructive; and
CLASS VI. Feelings corresponding with relations between interactions.

CLASS I.—The first great group of feelings, including *those that correspond with interactions that primarily subserve or oppose the conservation of the organism*, subdivides into two secondary groups, characterised by the way in which the interaction begins. One of the Sub-classes of feelings corresponds with actions that are initiated by the environment, the other corresponds with actions that are initiated by the organism. Each of the secondary groups thus formed is again divided according to the third of the principles already set forth—the directness or indirectness of the correspondence—into two tertiary groups, which we may term Orders. So that of the first great class of feelings four well characterised divisions present themselves for examination. These we may now take in detail, *seriatim*.

Sub-class I. *Feelings that correspond with interactions primarily affecting the conservation of the organism which are initiated by the environment.*

Order I. *The correspondence is direct.*

When thermal undulations impinge upon the surface of the organism; when a body comes in contact with the skin; when a chemical change takes place in a mucous membrane; when sonorous undulations strike upon the tympanum, or ethereal undulations on the retina,—in such cases a feeling arises which corresponds directly in duration, in intensity and in volume, with the action of the environment on the organism, and such feelings are termed Sensations. Sensations are to a large extent unconditional. If the action takes place the feeling necessarily arises, the bodily structure being supposed normal. The action taking place on what is physiologically the surface of the organism, there is a minimum of opportunity for the introduction of the intellectual element, intelligence arising only when the correspondence between the organism and the environment begins to extend in space. Whatever part cognition plays in the process is therefore subordinate. Feelings of this simple character can exist in the absence of almost every trace of cognition, and where cognition exists, it is in every case secondary to the feeling. These relations to cognition hold true when the feeling is represented as well as when it is presented. In the next order of feelings, in which the correspondence is indirect, we shall find that cognition rises into a position of much greater importance.

Environmentally-initiated Sensations are classified according to the nature of the agent by which they are aroused, as follows:—

TABLE I.

CLASS I. Sub-class I. Order I.

Self-conservative Environmentally-initiated Sensations.

The agent is		
Thermal vibration	of plus quantity, or more ample than that in the organism	Warmth.
	of minus quantity, or less ample than that in the organism	Cold.
Mechanical force	of inappreciable magnitude	Touch.
	of appreciable magnitude	Pressure.
Chemical rearrangement	on the surface	Smell.
	within the surface	Taste.
Aerial undulation	irregular	Noise.
	rhythmical	Sound.
Ethereal undulation	of which variations in amplitude correspond with variations in	Light.
	of which variations in rapidity correspond with variations in	Colour.

Little comment is, I think, required upon the above table. Objection may be taken to the expression "inappreciable magnitude" as applied to the mechanical agent with which the feeling of Touch corresponds, for it may be said that if the touch is felt, the force is *ipso facto* appreciated; but I know not how otherwise to express the fact that the feeling of Touch proper depends upon mere contact—upon the application of a force so small as to be virtually unmeasurable. If this term were substituted, an analogous objection might still be offered, for it might be said that the force exerted, for instance by the friction of a hair upon the skin, could be measured by a sufficiently delicate apparatus. The distinction that I have drawn between the action that provokes Taste and that which provokes Smell is not a recognised distinction, but from the following considerations it appears valid. That the processes that give rise to Taste and Smell are closely similar, if not the same, is indicated by the familiar fact that when smell is lost taste is greatly diminished. Smell arises much more rapidly than taste. Unless the sapid substance is unusually pungent or in strong solution, there is not usually any feeling of taste until it has been for some moments in the mouth. Often there is a very distinct interval before taste begins. It is difficult to see any adequate cause for this delay other than the necessity of the sapid substance to penetrate through a certain thickness of tissue before it can reach the nerves of taste; and this penetration or soaking of course requires time. No such delay occurs in the case of smell. In children, in whom the mucous membrane of the mouth is thinner than it is in adults, the feeling of taste arises much more readily, but no such difference exists in the case of smell. The pure tastes—of sweetness, sourness and bitterness—depend on the action of crystallisable substances, that is, of substances whose distinguishing physical property is the readiness with which they pass through organic membranes. No such peculiarity characterises the bodies that elicit the sense of smell.

Order II. *The correspondence is indirect.*

The second order of environmentally-initiated feelings is that in which the state in the organism which we call feeling corresponds, not with the actual operation of an agent upon the surface of the organism, but with the relation which some circumstance in the environment bears to the organism. The action of the environment on the organism with which the feeling indirectly corresponds being not actual, but removed to a distance in time and space, there can arise in the organism no state answering to such action except by the extension of the correspondence in time and space, and this correspondence is intelligence. If the agent is not directly acting upon the organism, but the feeling corresponds with the relation in which the agent stands to the organism, then for the feeling to arise this relation must first be known. As far as concerns any effect upon the organism, an unperceived relation is nothing. Hence, of feelings of this order cognition forms a part; a subordinate part indeed, but one of integral and even antecedent necessity. So far from being, like feelings of the previous order, unconditional, they are absolutely conditional on a previous process of cognition. A difference in the subjective aspect of the two orders of feelings is also important. The Sensations that have been considered have no inherent quality of pleasurableness or painfulness. Each may be pleasurable under some circumstances, painful under others. The quality of the feeling, when it exists, corresponds not with the nature of the action, but with its degree. A small increase of warmth or coldness is not necessarily either pleasurable or painful. When the degree of change becomes considerable, some degree of pleasure or pain commonly accompanies it. When the change is great there is always pain. The same is true of pressure, of light and of sound. A small degree of either of these actions is not necessarily either pleasurable or painful. A great increase in the amount of any of these actions is always painful. But in the feelings now to be considered, termed Emotions, the pleasurable or painful quality is not dependent upon the amount of the action, for direct action there is none. The quality of the feeling depends upon an attribute of the circumstance with which the feeling corresponds; and when this attribute is present, however trifling the amount of the feeling, it has a definite quality. When the circumstance is noxious, the corresponding feeling is painful. When the circumstance is beneficent, the feeling is pleasurable. It is evident, therefore, that the quality of the circumstance supplies us with a means of dividing into subordinate groups the present class of feelings. Previous, however, to this classification according to the quality of the circumstance, a more important division has to be made depending on its nature. The circumstance in the environment which elicits the feeling may be either a state or a process—either an agent or an event,—and the feelings aroused exhibit a corresponding variation.

TABLE II.

Class I. Sub-class I. Order II.

Self-conservative Environmentally-initiated Emotions.

The feeling corresponds with the relation to the organism of	an Agent in the environment which is cognised as	actively noxious	Antagonistic Feelings.
		passively noxious	Feelings of Repugnance.
		beneficent	Kindly Feelings.
	an Event in the environment which is cognised as	noxious	Grievous Feelings.
		beneficent	Joyous Feelings.

The Antagonistic feelings and the feelings of Repugnance, which have a close affinity, might be grouped together under the name of Antipathetic feelings.

The first of the five groups thus arrived at is the large and important genus of Antagonistic feelings. The feelings belonging to this genus are more numerous, more strongly and distinctly characterised, than those of any other group of corresponding value, and the reason is not far to seek. If the feelings correspond with the interactions between the organism and its environment, and if they have come into existence by a slow process of evolution extending from the dawn of life down to the present time, then the largest and most important group of feelings will be that which corresponds with that group of interactions which in the history of the race have been most numerous and most important. To which interactions this description applies there can scarcely be two opinions. Man, like every other organism, has arrived at his present state of development by the survival of the fittest in a ceaseless struggle for existence that has been in progress for countless myriads of years. During all this incalculable time the circumstance that has been most potent in shaping his organisation, has been the pruning and moulding influence of the adverse conditions against which he has had to struggle; in other words, the action of noxious agents in the environment. From this consideration we might predict that the group of feelings corresponding with the action of such agents must be the most important group of the environmentally-initiated Emotions, and when we find that it is so, we may fairly regard the fact as tending to corroborate the naturalness of the classification.

The most fundamental division that can be made of agents of this class refers, it is manifest, to the magnitude of their power with respect to that of the organism. No quality of a noxious agent can be of such importance, or exert so much influence on the state of the organism produced by its proximity, as the relative powers of this agent and of the organism. Since, as has already been pointed out, in feelings of this class the agent is not actually acting upon the organism, but is separated from it by an interval in time and space, it is clear that not only must cognition of the agent precede the occurrence of any feeling, not only must cognition of its noxiousness precede the occurrence of any Antagonistic feeling, but a cognition of the relative power of the agent is also necessary before a feeling of any definiteness can exist. Furthermore, just as the quality of the feeling as Antagonistic depends, not upon the attribute of the agent as it actually exists, but upon its attribute as cognised—a cognition which may be widely discrepant from the truth; so the sub-group, or sub-genus of antagonisms into which the feeling will fall will depend, not on the actual relation which the power of the agent bears to that of the organism, but on the relation that is cognised. To take an example: the feeling of Terror which, I say, arises on the cognition of the accessibility of the organism to a noxious agent of overwhelming power, will not arise unless the accessibility is cognised, nor unless the noxiousness is cognised. But this is not all. Cognition of these relations will determine the arousal of some Antagonistic feeling, but for this feeling to assume the gravity of Terror a further cognition must be added. The power of the agent must be cognised as overwhelming. The concurrence of these three cognitions is a necessary prerequisite to the feeling of Terror. To descend still further into particulars, and to take a case the most unfavourable to the doctrine here advanced: A woman goes into a paroxysm of terror at the sight of a mouse. How are the conditions satisfied in such a case? That the cognition of accessibility is a condition of the feeling is seen in the fact that if the mouse is encaged terror is not felt; or if felt, the chance that "it may get out" is assigned as a reason. That the mouse is believed to be noxious, and that in a high degree, is sufficiently evident. Doubtless, cross-examination might not elicit any precise form of injury to be feared,—that is to say, the cognition is not necessarily definite, but its vagueness is sufficiently compensated by its strength, which no amount of argument can overcome. So far the conditions are satisfied, but is the power of the mouse cognised as overwhelming? If not, the scheme falls to the ground; and at first sight it seems very difficult to say that it is. Of course, as far as mere mechanical strength is concerned, the supposition cannot be entertained, the comparison is absurd. But the word "power," as used here, includes far more that this. It means capacity of doing injury, which includes the element of unavoidableness. However overwhelming may be the mere mechanical strength of the agent, yet if it is easily escaped, its capability of inflicting injury is limited; and on the other hand, the agent may be weak to insignificance in mere mechanical strength, and yet have other sources of power which render it in the highest degree formidable. Such an agent is a venomous snake;

and when it is remembered that the terror inspired by such an agent will be greater the less the means of defence, the smaller the opportunity of escape, and the more rapid the movements of the snake, it becomes apparent that the power spoken of is not necessarily mechanical energy but power to injure, and includes as part of that power the element of unpreventableness or inescapableness. The whole of the qualities may be summed up as degree of noxiousness. Now let us return to the case of the mouse, and observe that, while its power of inflicting harm, should it gain access to the organism, is cognised very indefinitely but still very vividly as considerable, the astonishing rapidity of its movements proves it to possess a power of gaining access to the beholder which is far beyond her ability to prevent or avoid; and thus the degree of noxiousness, which may be regarded as the product of these two factors, is maintained at a very high estimate by the magnitude of the one factor, notwithstanding the moderate value to be attached to the other. As thus defined, the power of the agent is cognised as overwhelming compared with that of the organism, and the doctrine holds good.

Take another instance of the feeling of Terror—the feeling experienced by a child on entering a dark room. There is nothing in the room that can harm the child—no agent in the environment to arouse the feeling. Can the formula be said to apply to such a case? Assuredly it can. True, the room is in reality empty of ought but harmless furniture, but it is peopled thick with terrible things by the child's imagination; and it is the agent that is cognised, not the agent that actually exists, that arouses the feeling. Moreover the child's accessibility to the agents is cognised as a maximum. It cannot see, but it imagines itself as seen, and in comparison with its own helplessness to avoid its unseen foes, their power is conceived as overwhelming.

The relative power of the noxious agent to inflict injury, in comparison with that of the organism to avoid it or to nullify it by counteraction, is of course not precisely measurable. Nor is precise measurement any condition of the feeling. Between agents that, in comparison with the organism, are overwhelmingly powerful, and those whose power is by the same standard insignificant, there is an infinite number of degrees, and although the power of any given agent can never be precisely estimated, it is assigned to some more or less definite position in the scale, and the feeling that it arouses occupies a corresponding position. The scale may be broadly divided into five regions. There are agents whose power to inflict harm is cognised as approximately equal to the power of the organism to avoid or counteract them. Above these are those agents whose power is cognised as superior to that of the organism; which again admit of division according as the superiority of their power is cognised as moderate or as altogether overwhelming. Below the middle point of the scale are those agents whose power is cognised as inferior to that of the organism, and these again are redivided according as they are moderately inferior or insignificant. With these five degrees of difference in the comparative power of the noxious agent correspond five groups of Antagonistic feelings.

The inferior groups and individual feelings are marked off from one another by minor differences in the nature of the interaction: by the presence or absence of counteraction on the part of the organism, by the form which this counteraction takes, and by its success or failure; each of these differences in the interaction between the organism and its environment being paralleled by a corresponding difference in the feeling aroused. The detailed classification of the Antagonistic feelings is given in the annexed Table.

If the names of the feelings enumerated in the last column of this table are read in the order there given from above downward, it is at once evident that this is not the order of their affinity. The feelings of Terror and Fear which are so closely allied that they differ in degree only, are separated by feelings so widely different from either of them as Resignation, Desperation and Hope. Similarly the feelings of Revenge and Resentment, which have manifestly a close kinship, are separated by feelings so alien from them as Patience and Suspicion. Stubbornness and Sulkiness are widely separated by the intervention of feelings so unlike them as those of Rage, Triumph and Apprehension. It would be easy to bring these allied feelings together by shuffling the cards a little. If we transpose the second and third columns, and make the primary divisions according to the nature of the reaction and the secondary divisions according to the relative power of the agent, we bring together Terror and Fear, and follow them immediately by Hate, Annoyance and Contempt. Similarly, Resignation, Patience and Meekness, would form a separate well-characterised group; and other groups as natural would follow. But on the other hand by this arrangement Terror would be separated from Despair, Hate from Anger and Revenge, Annoyance from Vexation, and other closely allied feelings would have to be placed far asunder. From this it would appear that the classification here proposed is open to the same objection as those that I have rejected—of grouping together things that are widely unlike, and separating widely those that are closely allied. If my aim were to arrange the feelings serially, this objection would of course be valid, and the classification futile; but I have already declared that this is not my aim. So far from it, indeed, I hold that, as Mr. Spencer asserts of the arrangement of animal forms, "such relations cannot be represented in space of two dimensions [even]; but only in space of three dimensions." In a diagram such as that afforded by the table, the serial arrangement distorts and dislocates the actual relations of the feelings, somewhat as Mercator's projection distorts the relations of land and water on the surface of the earth. Mercator's projection seeks to represent on a plane surface the relations existing on a curved surface,—to reproduce in a diagram of two dimensions relations existing in space of two dimensions; yet how imperfect is the result! Judge, then, of the possibility of representing in space of one dimension relations that require three dimensions for their true exposition.

A fairly adequate concept of the inter-relations of the

TABLE III.

Class I. Sub-class I. Order II. Genus 1: The Feelings of Antagonism.

The feeling corresponds with the relation to the organism of an Agent in the environment which is cognised as actively noxious.	and of overwhelming power	and does not elicit counteraction.			Terror.
		and elicits counteraction	which is incipient.		Desperation.
			which is voluntarily suppressed.		Resignation.
			which becomes actual	and is successful.	Triumphant. Exultation.
				and is unsuccessful.	Despair.
		but the cognition is uncertain.			Hope.
	and of superior power	and does not elicit counteraction.			Fear.
		and elicits counteraction	which is incipient.		Courage.
			which is voluntarily suppressed.		Patience.
			which becomes actual	and takes a passive form.	Stubbornness.
				and is successful.	Triumph.
				and is unsuccessful.	Defeat.
		but the cognition is uncertain.			Apprehension.
	and of approximately equal power	and does not elicit counteraction.			Hate.
		and elicits counteraction	which is incipient.		Anger.
			which is delayed.		Revenge.
			which is voluntarily suppressed.		Patience.
			which becomes actual	and takes a passive form.	Sulkiness.
				& of moderate intensity.	Rage.
				and extreme.	Fury.
				and is successful.	Victory.
				and is unsuccessful.	Mortification.
		but the cognition is uncertain.			Suspicion.
	and of inferior power	and does not elicit counteraction.			Annoyance.
		and elicits counteraction	which is incipient.		Vexation.
			which is delayed.		Resentment.
			which is voluntarily checked.		Meekness.
			which becomes actual	and is successful.	"Satisfaction of Success."
				and is unsuccessful.	Mortification.
	and of insignificant power	and does not elicit counteraction.			Contempt.
		and elicits counteraction.			Scorn.

Antagonistic feelings may, however, be gained, if we conform to the necessary conditions. Let us imagine the most general of the relations that govern the classification of these feelings—the degree of noxiousness or the relative power of the noxious agent—to be represented by a solid stem; and let us suppose this stem to have five nodes, corresponding with the five relations that the cognised power of the noxious agent may bear to that of the organism; the node at the top representing those in which the power of the agent is insignificant and the node at the bottom those in which its power is overwhelming. At each of these nodes the corresponding group of feelings enumerated in the table may be represented as arranged round the stem in what is known to botanists as a whorl; each feeling being represented by a projection, separated from its adjoining fellows by a notch, which will be deeper or shallower according as the difference is more or less pronounced. Now, since there is no abrupt division between those agents that are approximately equal in power to the organism and those that are superior and inferior, nor is there any demarcation between these two groups and those which lie above and below them respectively, it follows that, to make the diagram correspond, we must imagine the projections that we have placed at the nodes to be extended up and down the stem as continuous buttresses, uniting the feeling placed at a node with the allied feelings at the nodes above and below on the same meridian of the stem. The notches will now become grooves and the stem a fluted column. Lastly, since those feelings which relate to an agent of greater power are of greater magnitude than those which relate to an agent of lesser power, they should be represented on our solid diagram by the greater size of the projections which correspond with them. The fluted column will thus become a fluted cone. At the base of the cone a great protuberance will represent the feeling of Terror, which is bounded by, and in some part continuous with, the feelings of Desperation on the one side and of Despair on the other. When we follow this protuberance upward toward the apex of the cone, we find that it gradually merges into Fear, while its neighbours similarly graduate, the one into Courage, the other into Defeat. Followed still higher, Fear narrows first into Hatred, then through Dislike into Annoyance; Courage becomes first Anger and then Vexation; and Defeat becomes modified into Mortification of various degrees. If, instead of noticing the connections among the feelings, we pay attention to the divisions between them, we find additional evidence that this solid diagram truly represents their relations to one another. For if the buttresses are large and prominent at the base and diminish towards the apex, it is but stating the same fact in another way to say that the divisions between them at the base are deep, and become more and more shallow as they run upwards, until at the apex they disappear. And if we turn from the diagram to the feelings whose relations it represents, we find that the differences between them have a corresponding disposition. Between the Despair that attends a failure to counteract the action of a noxious agent whose power is cognised as overwhelming, and the Triumphant Exultation that follows an unexpected success, the interval is as great as can possibly exist between feelings of the same genus. Between the Triumph that attends success over an agent previously cognised as superior, and the wretchedness of Defeat that attends failure of the counteraction, not only is the difference less than in the previous case, but other things being equal, it is less in exact proportion as the power of the agent is cognised as less overwhelming. When the agent is approximately equal in power the gap between the feeling aroused by success and that aroused by non-success, though still very considerable, is manifestly less. As the agent becomes less and less powerful, the interval between the two sets of feelings aroused by success and by non-success diminishes more and more, until as the agent becomes insignificant the feelings subside into a dead level of indifference. Again, the feeling of abject Terror that accompanies the absence of all effort to resist an overwhelmingly powerful enemy differs very widely from the feeling of Desperation that accompanies the strenuous effort to resist. Between Fear, the homologue of Terror, and Courage, the homologue of Desperation, the interval, though still great, is not so great. When we rise to the next "whorl" of feelings, in which the relative powers of the agent and the organism are cognised as approximately equal, the corresponding feelings of Hate and Anger are still less widely different, and are shown to be so by the comparative ease with which the transition is made from the one to the other. In the succeeding group the feeling of Annoyance which accompanies passivity, and that of Vexation which goes with active counteraction, are so little different that the terms are often used interchangeably; and when the agent is insignificant the two feelings coalesce into the single state Contempt: of which Scorn is properly only the outward expression.

From these considerations it will, I think, appear that the similarity between the feelings of Hate, Anger, Revenge and Rage in the third group, and between those of Annoyance, Vexation and Resentment in the fourth, so far from telling against the validity of a classification in which they are differently described, actually tells in its favour. Furthermore, I trust that a claim has been made out, not only for the recognition of the Antagonistic feelings as a natural and well-characterised group, but also for the validity and correctness of some such internal structure of the group as that which I have proposed; an arrangement which displays the lateral and cross relations of the various feelings in the group as well as their more obvious kinships.

It will be seen that in the classification proposed each feeling has not only assigned to it a position, but also has its nature stated and defined. In doing so, as in all cases in which terms are taken from the vernacular and applied to the purposes of science, the meaning of the terms at the same time that it is rendered precise is necessarily somewhat altered. It is probable that in some cases a term has been used to connote a feeling not quite the same as that to which it is applied in common use. I can only say that

I have tried to bring the expressions as nearly as possible into harmony with what appeared to be the commonly received meaning of the term used; and that, when I have thrust into a definite mould a term which as commonly used has but a hazy significance, I must ask the reader to accept the connotation that I attach to it so long as he is estimating the validity of the classification.

CHAPTER XIII

CLASSIFICATION OF FEELINGS—*Continued*

CLOSELY allied to the Antagonistic feelings, and blending with them on their common frontier, is a group (Genus 2) which I have called the feelings of Repugnance, and which are distinguished from the preceding genus by a small but decided difference in the character of the circumstance in the environment with which they correspond. In the case of the Antagonistic feelings this circumstance is an actively noxious agent,—that is to say, an agent whose action would be noxious if applied to the organism, and which is credited with the ability to gain access to the organism, or at any rate to attempt to do so. In the present genus the latter quality is wanting. It is still believed that the agent would be noxious; it may be intensely noxious, if applied to the organism; but it has no power of itself to gain access to the organism. The element of accessibility, so important in the preceding genus, is absent, and this difference divides the one group from the other. We have already seen that in the circumstances arousing Antagonistic feelings the element of accessibility is of prime importance. We may, therefore, expect the class of feelings from whose evoking circumstances this element is absent, to exhibit a well-marked difference. On the other hand, since there is every degree of accessibility, from none to a maximum, we may expect the feelings of this group to graduate into those of the previous one.

When a circumstance in the environment is passively noxious in the sense here used, it is obvious that it cannot act upon the organism, and its noxiousness cannot be exerted unless and until the organism spontaneously approaches and uses or meddles with it. From this it follows that, when there is reaction on the part of the organism, this reaction takes the form either of avoidance or of ejecting the noxious circumstance from the environment. Obviously circumstances thus characterised, although they are antagonistic to the conservation of the organism, are so in a far less degree than those in which the noxiousness is active, and hence it follows that the Repulsive feelings as a group lie upon the confines of the great Class (I.) of feelings that we are now considering—those that affect the conversation of the organism—and approach in character those of Class V., which correspond with actions that are neither conservative nor destructive. When we observe that this last Class includes the Æsthetic feelings, it will, I think, be admitted that there is a real and well recognised connection, partly direct, partly antithetical, between them and such feelings as Horror and Disgust. Circumstances that are passively noxious are much less common than those whose noxiousness is active, and hence feelings of the class now considered are much less numerous and less definitely characterised than those of Antagonism.

If the matter be considered in the light of Evolution, it will appear that in the history of the race a vast number of cases in which a thing has been spontaneously meddled with by the organism and thereupon found to be noxious, have been cases in which the thing was taken as food. Hence may be formed a natural division of the Repulsive feelings according to the way in which the noxiousness is manifested.

TABLE IV.

CLASS I. Sub-class I. Order II. Genus 2: The Feelings of Repugnance.

The feeling corresponds with the relation to the organism of an agent in the environment which is cognised as passively noxious.	to the taste	and moderately noxious.	Disgust.
		and intensely noxious.	Loathing.
	in other ways or generally	and not of superior power.	Dislike.
		and of superior power.	Abhorrence.
		and of overwhelming power.	Horror.

The feeling of Horror occupies in this class a position homologous with that of Terror in the last, the sole difference being the character, as active or passive, of the noxiousness of the circumstance by which they are aroused. Now a circumstance which is only passively noxious will not be cognised both as noxious and as of overwhelming power, unless both of these qualities are very conspicuous. Every agent whose power is overwhelming is passively noxious, since if we get in its way it will crush us, but in the great majority of such cases the power alone is cognised. The noxiousness, being inconspicuous, is omitted from the cognition, and the feeling aroused is one of a simpler class, which will be subsequently considered. Nevertheless, in every such circumstance the noxiousness is potential, and only needs to be cognised for the feeling of Horror to arise. A few concrete examples will make the matter clearer. When we approach the brink of a stupendous cliff, we experience, in addition to and apart from any feeling of giddiness, a vague feeling of Horror. This feeling arises from the cognition of the possibility of falling over. The circumstance which renders such a catastrophe possible is cognised as of overwhelming power and as noxious, both these qualities being conspicuously present, but since its power will not be exerted unless we voluntarily approach the brink and precipitate ourselves from it, the noxiousness is passive. If a man is in the hands of enemies who are carrying him to the brink to throw him over, the noxiousness is no longer passive in the sense here used, and the feeling aroused is one not of Horror but of Terror. When we view the action of some immense machinery, such as that which propels a great ship through the water, we are in the presence of an agent of overwhelming power; but, since the latent noxiousness which every such agent possesses is inconspicuous, the feeling aroused is one due to the cognition of the power only —a feeling of Admiration or even Awe. But now suppose we are shown the place where some workmen became entangled in the machinery and was torn to pieces; instantly the feeling changes to Horror; and why? Because the latent noxiousness has now become conspicuous, and its addition to the qualities already cognised brings about the change of feeling. Still there is no terror, for the machinery being powerless to harm us unless we interfere with it, the noxiousness is cognised as passive. This latter instance is an example of the most numerous class of cases of passive noxiousness, in which the noxiousness is not cognised at all unless it is displayed. If, however, this quality is exerted upon the organism it ceases to be passive. It at once enters the active class and the feeling aroused is one of Terror. Manifestly the only way in which the noxiousness can be displayed and yet remain "passive" is by being exerted on some one else. Hence the great majority of feelings of Horror are associated with the cognition of severe injuries suffered by other people. Hence railway and other accidents and surgical operations are common occasions of this feeling. The gallows and the guillotine, the Black Hole at Calcutta, the Well at Cawnpore, arouse feelings of Horror, and so do all similar spectacles.

Where the circumstance in the environment is passively noxious and its power, without being overwhelming, is yet superior, in so much that the organism cannot abolish it, then the feeling of Abhorrence is aroused. Such circumstances are not common, and the feeling is therefore not well characterised. As in the case of Horror, the noxiousness may be cognised only when it is exerted towards others, and such cases are found in the Abhorrence with which a refined nature regards a bull-fight, or a prize-fight, or a father unmercifully punishing a child. An example of the feeling aroused by a noxiousness which is passive but more directly concerns the organism is seen in the Abhorrence with which a drunken husband is regarded by a refined woman.

Agents of inferior power that are passively noxious will not commonly arouse any feeling at all. If I tread upon a sharp stone or run a thorn into my flesh, there arises of course the sensation of pain from the wound, but the circumstance in the environment, the stone or the branch, does not, I think, arouse any emotion sufficiently definite to receive a name.

An environmental circumstance which is noxious to taste is of necessity passively noxious, since we taste only those things that we voluntarily put into our mouths ; when the operation is complete there is the unpleasant Sensation of distaste. But when the thing is not yet tasted, but stands in such a relation to the organism as to arouse a cognition of the process of tasting, then the feeling is of Emotional order, and where the thing is cognised as noxious, the emotion is one of Disgust. If it is cognised as excessively noxious the emotion is one of Loathing. That this is the true nature of these feelings does not, I think, since the writings of Darwin, require a laboured demonstration.

The connection between the feelings of Disgust and Loathing on the one hand, and Abhorrence and Horror on the other, is indicated no less by the similarity in the character of the circumstances which arouse them, than by the fact that they are all associated with nausea, and when pushed to excess, with actual vomiting.

Genus 3. The feelings which correspond with the relation to the organism of a *beneficent* environmental circumstance, are, as in the case where the circumstance is noxious, divisible according to the character of the circumstance as active or passive. The feeling aroused by an agent which is beneficent actively—that is to say, by gifts or services rendered to the organism—differs from the feeling aroused by a circumstance that is passively beneficent,—that is to say, whose mere presence in the environment is beneficial to the organism. In feelings of this group the cognised power of the agent with respect to that of the organism is a much less important element in determining variations of the feeling than it is in the previous group. In the presence of a noxious agent, such a cognition is all-important. The mode of reaction of the organism is determined very largely by the estimate that is formed of the power of the agent, and feeling, which is the correlative of action, must vary and does vary greatly with the same estimate. But in the case of a beneficent agent it is manifest that its power with respect to the organism is much less important, and hence the divisions of feeling on this basis are much less numerous.

TABLE V.

CLASS I. Sub-class I. Order II. Genus 3 : Kindly Feelings.

Feelings corresponding with the relation to the organism of an agent in the environment which is beneficent.	actively	and is not of overwhelming power.	Gratitude.
		and is of overwhelming power.	Reverence.
	passively	and is not of overwhelming power.	Liking to Affection.
		and is of overwhelming power.	Devotion.

Inspection of this Table will doubtless elicit the criticism that the distinction between an agent that is beneficent by its mere presence, and one that is beneficent by service rendered is one that cannot always be made; but the reply is that the feelings defined by this distinction are so closely allied that the distinction between *them* cannot always be made, and that the imperfect limitation of the definition corresponds with the imperfect limitation of the thing defined and so justifies itself. Although the two varieties of beneficence often coexist in the same agent, and the feelings of Gratitude and Liking are consequently often present together, yet the more completely the beneficence is, or is cognised as, active, the more does the feeling partake of the nature of Gratitude, and the more completely passive the beneficence the more unalloyed is the feeling of Liking. That Gratitude does not arise save in correspondence with the circumstance of gifts or services rendered, every one will admit. It is universally accepted that Gratitude is the name given to feeling that arises under such circumstances. It follows, therefore, that the feeling of Liking, and its intenser form Affection, do not arise under such circumstances. Of course it is possible, and it is very frequent, to like a person who renders us services, but this feeling, although it is commonly mingled with the feeling of Gratitude, is yet quite distinguishable from it.

Doubtless in the case of a much-loved person, with whom many gifts and services have been interchanged, the volume of kindly feeling that is at length generated does not admit of separation into parts, so much being scored to Gratitude and so much to Liking; but it is not in the complex cases that an explanation is first to be sought. Whatever laws are found to rule the simple cases rule also, we may be certain, the cases that are formed by compounding of the simple cases, although in the latter their operation may be so disguised by mutual interference as to be unrecognisable. Further, it must be admitted that a feeling that begins as Gratitude may, and often does, merge into Liking; but it is easy to see how this may occur without invalidating the distinction here made. Suppose the case of a child that receives a gift and feels Gratitude towards the donor and pleasure in the gift. The next visit of the donor will, according to a well-known psychological law, arouse in a faint form the pleasurable feelings originated by the reception of the gift. The donation is repeated, and again the gratitude and the pleasure are aroused. On the next visit these feelings will again arise faintly, but more vividly than on the former occasion, and with each repetition the pleasure aroused by the mere presence of the donor will be augmented. When the pleasurable feeling so aroused becomes appreciable in amount independently of the Gratitude, it is termed Liking; and such a feeling obviously satisfies the definition I have given, for it is the feeling aroused by the mere presence of a beneficent agent and not directly by the circumstance of gifts or services rendered. The distinctness of the two feelings is well seen in the fact that a service may be rendered to us by a person whom we do not like, and may arouse its corresponding feeling of Gratitude without the antipathetic feeling of Dislike being by any means abolished. An example occurs when we receive gifts of the white-elephant character from a kindly-intentioned bore. We do not like the donor. We may feel an actual repugnance to him. He is a nuisance, and his gift is a burden; but at the same time we cannot help feeling some Gratitude towards him. Or take the case of a stern undemonstrative man who lavishes gifts upon a lad who dreads him. The lad is never at ease in his presence, dreads the sound of his footsteps, longs for his departure, has no shred of liking for him, but yet is deeply grateful to him, and would go through fire and water to serve him. On the other hand, liking may exist quite apart from gratitude. We all like Falstaff; and I suppose most of us can reckon among his acquaintances at least one "rip," to whom we have certainly no feeling of gratitude, but whom we say we cannot help liking.

From these considerations it appears that Gratitude and Liking or Affection, however closely they may become entangled in some cases, are quite separate in their origin; and since the former is always aroused by gifts or services rendered, and since such circumstances, if they arouse any feeling at all, arouse that of Gratitude, it follows that the feelings of Liking and Affection must correspond with some other relation of the environmental agent to the organism. This relation I have stated to be that of an agent which is passively beneficent or beneficent by its mere presence. The question is, How can an agent be beneficent in this sense? Only, it is evident, by affording or increasing the conditions for the exercise of some activity on the part of the organism. All cases of Liking will, I think, if examined be found to answer this description. One man likes the country, another the town. Why? Because the country affords that one and the town this one the most favourable conditions for exercising his activities. If I like a quill-pen better than a steel-pen, it is because the former is easier to write with—offers more favourable conditions to activity. If one man likes as a companion a good listener and another an amusing talker, it is because the proneness to activity in the first is greater in speech, and in the other in other operations, and hence the amount of activity facilitated is greater when the first gets an opportunity to speak and the second an opportunity to listen. If I like this picture better than that, it is because, as will appear when the Æsthetic feelings are considered, this one requires less exertion on my part to appreciate than the other—in other words, the activity required of me is more facilitated. The term "activity" is here used in a larger sense than that of energy expended by the organism. Perhaps the expression "exercise of the faculties" would be in some respects better, but its connotation appears to me less definite. Apart from these instances, which of course do not cover the whole field, and which allow therefore of the retort that in other cases of Liking the nature of the relation with which the feeling corresponds is different, there remains the comprehensive argument that this relation is the only one possible. For if the agent is beneficent to the organism and its beneficence does not take the form of actively rendering gifts or services, what other form is possible? Manifestly the only other way in which beneficence *can* be shown is by affording opportunity for the exercise of some activity of the organism. It may be said that if an agent does facilitate our activities this itself is rendering us a service, and that the feeling of Liking is placed out of court, or rendered merely a variety of Gratitude. But there is a difference. If any activity is checked by some condition or the want of some condition in the environment, so that a definite desire results, then the removal or supply (as the case may be) of the condition, is recognised as a service rendered, and Gratitude is felt; but if the beneficent agent merely facilitates the exercise of an activity whose disuse has not reached the point of desire, the feeling aroused is not Gratitude but Liking. Clearly, however, the difference is one of degree, and concerns not indeed the degrees of beneficence of the agent, but degrees in the conditions of the organism. Hence we find that, when an activity has less means of expression than usual, any agent which affords these means is looked on not only with Liking but with a certain amount of Gratitude. For instance, we say that we like a friend to come and sit with us. But if we have been cut off from social intercourse by sickness we are grateful to him for the same action. Lastly, since Liking corresponds with the relation to the organism of an agent which facilitates the exercise of its activities, the volume of the feeling will vary with the amount and number of the activities that are facilitated, and its intensity with the degree in which their conditions are afforded by the agent in question. Hence powerful Affection for a house long dwelt in; hence too, the feeling of Liking with which the least patriotic people view their native shore after experience of the labour of conversing in foreign tongues. Hence also the Liking with which we regard an old friend, the representation of him calling up by association the vague remembrance of innumerable occasions of social activities facilitated.

The distinction that I have drawn between Reverence and Devotion as corresponding with a relation to agents that are active and passive respectively, is not, it must be freely admitted, one that is commonly present in the minds of those who use the terms, but I submit that it expresses a real difference in feeling, and that these two terms which are floating in common use to express vaguely any feeling that lies about the region here defined, may legitimately be taken and fixed one on one side of the line that I have drawn, and the other on the other; and it is possible to show, moreover, that some such connotation as that which I have attached to them is already to some extent inherent in the terms. Thus, we speak of a man being *devoted* to another person or to a cause when he serves it *without reward*, showing that the person or cause served is regarded as passive so far as beneficence is concerned. On the other hand the feeling of Reverence does not imply action on the part of him who reveres, so that if there is any action between the two it is effected by him who is revered. (A reverent demeanour is one which is as passive as possible; it is not only passive but demonstratively so. Not only is the body kept at rest when reverence is to be expressed, but it is placed in a position the furthest removed from that of incipient action. The head is bowed, the knees are bent, the hands are placed together.) So far, therefore, the vernacular use of the terms is in harmony with the meaning attached to them here. Both terms, however, are vaguely used, and it is not to be supposed that the majority of people would draw a distinction between feelings so closely allied.

But when things commonly confounded are for the purposes of science distinguished, it becomes necessary to limit the denotation of trite terms, and so long as this alteration of meaning is avowed and the new limitation declared, no harm is done.

Reference to Table II. will show that the next two Genera of feelings are distinguished by the fact that the environmental circumstance with which they correspond is not an *agent* but an *event*. The difference is clear and is considerable, and the feelings of these genera are as distinct from those of the last as a state is distinct from a change of state. Events are divisible just as agents are, into those which are noxious and those which are beneficent,[1] and the feelings exhibit a corresponding division. Every event is a change from an antecedent state to a consequent state, and is beneficent if the consequent is the more favourable of the two, noxious if the antecedent is the more favourable. The amount of the change—that is to say, the amount of difference between the antecedent and the consequent—regulates the intensity of the feelings, while its position in time is the basis for their specific character.

TABLE VI.

Cl. I. Sub-cl. I. Ord. II. Genera 4 and 5: Grievous and Joyous Feelings.

The feeling corresponds with the relation to the organism of an event in the environment which is cognised as	noxious	and distant in time.	Anxiety.
		and impending.	Dread.
		and imminent.	Alarm.
		and does not occur.	Relief.
		and has happened.	Anguish, Grief to Sorrow, Regret.
	beneficent	and impending.	Pleasurable Anticipation.
		and imminent.	Eagerness.
		and does not occur.	Disappointment.
		and has happened.	Joy, Delight to Gratification.

[1] There is a third group—those that are neutral or indifferent—but these do not primarily affect the conservation of the organism and are therefore excluded from the great Class of feelings that we are now considering. They will be examined in their place in Class V.

The foregoing Table explains itself, and does not, I think, require any comment. It completes the enumeration of those feelings of Class I. that *correspond with an interaction initiated by the Environment.* We now pass to the consideration of the second of the two great groups of feelings which together constitute this Class.

Class I., Sub-class II. *Feelings that correspond with interactions primarily affecting the conservation of the organism, which are initiated by the Organism.*

It has already been pointed out that the sub-division of the various groups of feelings is not necessarily determined by variations in the same circumstance in different groups. A little consideration will be enough to show that the qualities of interaction which determine the sub-divisions of this group of feelings must be very different from those in accordance with which the divisions of the previous group were made. In that case the quality of the action as noxious or beneficent was an element of prime importance in distinguishing between the sub-groups, but when an interaction is initiated by the organism itself, it is obvious that no such distinction applies. There is but one way in which the organism can spontaneously act upon the environment, and that is by means of muscular movements; and although the part of the organism that takes the lead in the movement may be very different in different cases, and although the direction, force, extent and duration of the movement may all vary very widely, yet it is evident that these are but differences of degree, and that no satisfactory classification of interactions can be founded upon them. It is evident that we must look for some principle, quite different from those that have been found of service in dividing the environmentally-initiated actions, to serve as a basis for classifying those which are initiated by the organism. Such a principle is found in the *stages* which these actions go through.

Expressed in terms of the adjustment of the organism to the environment, an act is a movement of the organism adjusted to an end (Spencer), and it is with this movement thus adjusted that the feeling corresponds. Regarded physiologically, an act begins as a nervous process. It is first of all an energising of the highest nervous centres or some of them. Although such a process is of course not itself an act, and although it may exist without the occurrence of any consequent act, yet whenever an act is performed such a process is a necessary antecedent—is the first stage of the continuous process which in its entirety constitutes the physiology of the act. The feeling, which is the state of the organism that corresponds with the action of the organism on the environment, begins when this action begins,—that is to say, it begins with the nervous process that eventuates in an act. But we have seen that not every nervous process does eventuate in movement. There is therefore a difference between the feeling that we are now considering—that which accompanies the earliest stage of the initiation of an action—and the feeling of purely intellectual exertion. This difference is on the physiological side a difference in the momentum of the discharged energy. If the energising of the nerve-regions concerned becomes so active that the liberated energy has sufficient momentum to overcome the resistance of the nerve-paths and to reach the muscles and set them in action, then there is a feeling of initiated action; but if this degree of activity is not attained, this feeling does not arise. Now the passage of the nerve-current from the highest nerve-regions to the muscles is not instantaneous. It occupies time. Between the attainment of the requisite tension or momentum on the part of the nerve-process and the resulting muscular contraction there is a brief but appreciable interval. During this interval there is no movement of the organism, but the act is already virtually begun; and in correspondence with this initiatory stage of the act there arises a feeling, which is part of the feeling appropriate to and corresponding with the act, and yet has a certain difference from the rest of the feeling which corresponds with the remainder of the act—with that part in which the movement from incipient has become actual. To those who know nothing of the physiological processes which eventuate in bodily movements, and to whom the movement of a limb is the first thing that happens in an act, the feeling that corresponds with the incipient stage of the act, and occurs before the movement, will appear to occur previous to and altogether apart from the act. Many things concur to confirm this notion of the separateness of this portion of the feeling from the act with which it corresponds. For every case in which the nervous discharge attains a tension sufficient to overcome the resistance of the outgoing channels and to reach the muscles, several instances occur in which a less powerful discharge occurs from which no movement results. In such cases a mental state arises which we call an idea of the movement, and which is precisely similar, save only that it is of inferior intensity or vividness, to the feeling corresponding with the incipient stage of an act. Such a feeling, since it is not associated with an act, is looked on as quite apart from action, and helps to confirm the notion of the independence of the intenser feeling also. Again, when the passage from the nerve-centres to the muscles is interrupted, as it often is in every one's experience, from temporary pressure on nerve or artery, an act requiring those muscles will stop short at its initiatory stage. Since the nerve-currents do not reach the muscles there will be no movements; but since the nerve-centre discharges with the requisite energy, and the first stage of the act occurs, the feeling appropriate to that stage will also occur. Furthermore, although this feeling is but an intenser form of the mental state which we call an idea of a movement, yet from this state it is sharply distinguished not by its intensity, which is a matter of degree and therefore does not admit of sharp distinction, but by its association with action. For while the intenser feeling always immediately precedes a movement, the fainter feeling never does. Often two or more of these fainter feelings arise in succession or in alternation, but they are not associated with movement until one of them obtains preponderance and emerges into the state of greater intensity, and this is the prelude to the corresponding movement. From these conditions it results that the feeling which corresponds with the incipient stage of an act is regarded as distinct on the one hand from the fainter feelings which it resembles, and on the other from the act with whose initiation it corresponds. To those who do not know of the existence of the incipient stage of an act, and who look upon the muscular movement as its earliest beginning, the feeling that accompanies its incipient stage will stand out in conspicuous isolation as the only and invariable antecedent to every outward act, and hence will inevitably be regarded as its cause. To this feeling is given the name of Will. (Genus 1.)

Those who are accustomed to regard Will as a separate and primitive faculty of the mind will of course dissent from this view of its nature. To some of them the whole system that is here advocated will be so discordant that a defence of a single position would be futile. Those, however, who admit the validity of Mr. Spencer's division of Mind into Feelings and Relations between Feelings ought not to be hard to convince. If Will is not what I have stated it to be, what is it? By hypothesis it must be either a feeling or a relation. If it is a relation, what are its terms? Until some answer is given to this question, which appears to me impossible, Will has no *primâ facie* claim to be considered a cognition. Whether it is a feeling or no may be reasonably discussed, but I do not think that any one will contend that it can be a cognition, and if not, then to those who accept Mr. Spencer's psychology there is no other alternative; it must be a feeling. Once it is admitted that Will is a feeling, and not a primitive division or faculty of Mind, its position among other feelings becomes a legitimate object of search. Whether the position that I have assigned to it is correct or no is not of much importance. What I wish to insist upon is that it is at least possible to assign to Will a definite position in a systematic arrangement of the Feelings, and thereby to harmonise the discrepancy between Mr. Spencer's fundamental division of mind and his subsequent classification of feelings. Every mental state, he says, is either a cognition or a feeling. Very well. Will is certainly not a cognition. It must then be a feeling. If it be a feeling, to what position in his classification are we to relegate it? Is it a presentative feeling? or a presentative-representative, or a representative, or a re-representative feeling? Mr. Spencer himself could scarcely give a satisfactory answer. The place I have given it may not be the correct one, but it does at least give it some position, and one which appears to me to accord with the fundamental principles of Mr. Spencer's System of Psychology.

Still, if Will be a feeling, it must be a very peculiar one. There must be something in its nature highly distinctive from all other feelings to induce so many great authorities to allot to it a position not only apart from the feelings but altogether separate and unique. An explanation of this fact is certainly required, and can, I think, be found in considerations of which the following is an outline. Returning to the physiological aspect of the question, it is to be noticed that the nervous process which is the objective condition of Will, although it has the characters common to all nervous processes, has one character that is special and unique. Other feelings have as their physiological basis the activity of this or that region of gray matter—a region which may be large or may be small, but which includes a portion only of the highest nerve-centres, and leaves other regions to be simultaneously and separately active, and to form the basis of simultaneous and different feelings,—that is to say, other feelings form a portion only of consciousness and are therefore considered to be distinct from the *Ego*, which is the sum total of all the states of consciousness at one time coexisting. But the nervous process that underlies Will is a far more extensive affair. It is not, as that of other feelings is, the activity of this or that centre or region; it is the resultant or algebraical sum of the activities of *all* the highest nervous regions. Hence the feeling which it underlies is in a special manner identified with the *Ego*. When I say I have a feeling of warmth or anger, I regard the feeling as something distinct from the *I* that feel it. But when I *will*, I regard the will as the expression of my whole self. And it is this identification of Will with the subject that constitutes its peculiarity as compared with other feelings, and that has led to its relegation to a region of mind apart from them.

The classification of the group of feelings with which we are now dealing depends, it will be remembered, upon the *stage* of the action of the organism on the environment at which the feeling occurs. The next feeling that we have to consider is therefore that which corresponds with the next stage of this action, and occurs when the current of energy is delivered from the nerves into the muscles and the muscular contraction takes place. Every spontaneous action of the organism on the environment is effected by muscular contraction, and the feeling accompanying a muscular contraction is therefore a necessary part of the feeling that accompanies every act, however the act may be performed and whatever part of the organism may be chiefly concerned in it. To this feeling we give the name of Effort. (Genus 2.) The simplest acts, such as phonation, turning of the head, and so forth, contain no other physiological elements than the nervous discharge and the muscular contraction. When these two stages are gone through the act is complete, and the corresponding feelings of Will and Effort alone occur. Further, it is evident that we have now exhausted the possibilities of feeling as it corresponds directly with activity of the organism pure and simple. The moment the action of the organism brings it into contact with a resisting body in the environment, at that moment a reaction of the environment is added to the action of the organism, a state of feeling corresponding with this reaction is added to that which corresponds with the action; and the total feeling that results is compounded of the two. Then arise the feelings of Resistance, Hardness, Softness, Elasticity and the like—states of mind that are more cognitive than sensitive, and that need only be referred to here for the sake of formal completeness. (Genus 3.)

It will be remembered that, in the case of the Environmentally-initiated feelings, we considered as a case of interaction between the organism and the environment the mere relation to the organism of an agent or event in the environment, even though the agent should never actually act upon the organism nor the event actually occur. The feeling, we found, corresponded with the relation to the organism of an action that was potential only—of an activity, real or not, but cognised. Similarly, in the Organismally-initiated class, we find that feelings may correspond with the relation to the environment of an act or group of acts of the organism which have not yet occurred and may never occur—which are as yet only possible or potential. As in the former case, the relation, to elicit a feeling must be cognised, and, as in that case, the feeling corresponds with the relation that is cognised, correctly or no, and not necessarily with the relation that actually exists. In the former case the means by which the cognition of the activity in the environment was reached, was regarded as outside the scope of our inquiry—as pertaining to the region of cognition and not of feeling; and similarly in this case the means whereby the organism forms an estimate of its own powers is for the present purpose disregarded. We have to postulate that such an estimate is formed, and upon that estimate, and the relations that it bears to cognitions of environmental circumstances, are founded the Emotions of the Organismally-initiated group.

Every activity of the organism requires for its fulfilment the existence of certain environmental circumstances. We cannot eat without food, nor drink without liquid, nor work without materials, nor converse without companions, nor take long walks on board ship, nor exercise any activity whatever unless the appropriate circumstances exist in the environment. The existence of these circumstances I call the *outlet* of the activity, and the action of the organism on the environment, and therefore also the corresponding feeling must, it is evident, largely depend on the quantitative relation that subsists between *activity* and *outlet*. The possible number of inter-relations between two independent variables, each of which may vary from zero to a maximum, is obviously infinite, but those of the two factors that we now consider may be collected for our purposes into a small number of groups. Outlet may be proportionate to activity, or there may be a margin of outlet beyond activity, or there may be a margin of activity beyond outlet; and these margins may be wide or narrow. These are all the relations that need concern us. Further, the relation that we consider may be that of a single activity to its outlet or that of a group or a large number of activities to their outlets. Taking first the general case, we find that where there is a large number of activities that are left unexercised for want of outlet, there arises in correspondence with this relation between the organism and the environment the massive feeling of Ennui, a feeling that becomes more voluminous the greater the number of activities that remain unsatisfied, and more intense the greater the discrepancy between activity and outlet. It matters not, so far as this feeling is concerned, how the absence of the outlet has been brought about. It may be due to a mode of life enforced merely by social penalties, or to the loss of the usual outlets and a want of plasticity in finding others, as in the retired man of business, in whom the margin of activity over outlet is but small and the feeling merely disagreeable; or it may be due to the incarceration of the individual in solitary confinement, when the deprivation of outlet for almost every activity augments the feeling of Ennui from a degree that is ordinarily mere Disagreeableness to one of intolerable Misery. When the absence or deficiency of outlet is prolonged, the feeling of Ennui merges into that of Discontent. On the other hand, when the outlets are ample, and sufficient to allow the free exercise of all activities, the corresponding feeling is one of Contentment. If we take the case of individual activities instead of that of activities in general, then, when outlet is absent or is deficient, the specialised feeling corresponding with this specialised relation is the feeling of Desire, a feeling which rises in intensity with the excess of any particular activity over its outlet. Should the activity from previous accumulation or other cause gush out so copiously on the occurrence of an outlet as to leave the organism exhausted, the negative feeling of Satiety results. When this condition extends to a large proportion of activities the individual is said to be *blasé*.

TABLE VII.

CLASS I. Sub-class II.: Self-conservative Emotions, Organismally-initiated.

Genus 4: Feelings corresponding with the relation of Activity to Outlet.

Feelings of Content and Discontent.

Activity exceeds Outlet	in the case of a single activity.	Desire.
	in the case of many activities.	Ennui.
	and the disproportion is prolonged.	Discontent.
Outlet is proportional to Activity	in the case of a single activity.	Satisfaction.
	in the case of many activities.	Contentment.
Activity has found Outlet in excess	in the case of a single activity.	Satiety.
	in the case of many activities.	*Blasé*ness.

The next genus of feelings corresponds with a relation of rather more specialised character. The outlet of an activity has been defined as the whole group of environmental conditions that are necessary for its fulfilment; and the feelings of the previous genus depended on the presence or absence of these conditions as a whole, and on the degree in which they as a whole were present. The feelings now under consideration depend on the relation which the activity of the organism bears, not to the conditions as a whole, but to a specialised part of them. When the main bulk of the conditions necessary for the exercise of any activity are cognised as existing in the environment, but a single one, or a small proportion of them, is wanting, the activity cannot, it is evident, be exercised, and the corresponding feeling of the previous genus will come into existence. But in addition to this feeling a somewhat more specialised feeling will arise, corresponding with the somewhat more special relation that is cognised. The absence of the condition or group of conditions is termed an *obstacle*; or if, as is common, the absence of the wanting condition is less prominent than the presence of some other condition to which the absence of the first is attributed, then the condition that is present is called the obstacle. In this, as in the last, case the feeling corresponds with the relation between two independent variables, and, as in that case, although the number of possible relations is infinitely great, yet they may be for our purposes arranged in a few groups each of which shades off on either hand into adjacent groups, and has corresponding feelings with corresponding graduations into neighbouring feelings.

TABLE VIII.

CLASS I. Sub.-cl. II.: Self-conservative Emotions, Organismally-initiated.

Genus 5: Feelings corresponding with the relation of Activity to Obstacle.

Feelings of Freedom and Restraint.

Obstacle is cognised as insignificant in comparison with Activity.	Freedom.
Obstacle is cognised as overwhelming in comparison with Activity.	Restraint.
Obstacle is cognised as great and Activity as great.	Determination.

Where obstacle and activity are both small it is evident that feeling will be inconspicuous, and hence to such feeling no name is applied.

Feelings of the two preceding genera correspond with the relation to environmental circumstances of an activity on the part of the organism,—that is to say, of an action that is potential but need not be actual. We have now exhausted all the possible relations of activity of the organism as distinguished from its action. In the next genus of emotions the stage of interaction between the organism and the environment is carried a step further. They correspond with an action that is no longer potential but actual. There must be some *work done* upon the environment by the organism before feelings of this genus can come into existence. Still, however, the emotion corresponds, not necessarily with the relation that actually exists but only with that which is cognised, the cognition being in this case mainly a remembrance. When actual action of the organism upon the environment takes place, the organism forms an estimate of the amount of energy that is expended by it. How this estimate is formed, on what basis it rests, and how far it is correct, are immaterial to our present purpose. All that is required to justify the constitution of the next genus of feelings is the admission that such an estimate is formed, and this, I think, no one will deny. Let us call the amount of activity that is cognised as put forth by the organism in the performance of an action the *exertion* of the organism. Then the next class of feelings will correspond with the relation that the Exertion of the organism bears to the Effect produced in the environment.

TABLE IX.

CLASS I. Sub-cl. II. : Self-conservative Emotions, Organismally-initiated.

Genus 6 : Feelings corresponding with the relation of Exertion to Effect.

Feelings of Power.

Exertion, compared with Effect, is cognised as	insignificant.	Power.
	slight.	Ease.
	considerable.	Difficulty.
	overwhelming.	Impotence.

Some comment upon this Table is rendered necessary by the fact that the terms used in naming these feelings are not always employed in the same sense. The feeling of Power, I have said, arises when the Exertion necessary to produce a given effect is cognised as insignificant in comparison with the Effect produced. Hence this emotion will, if this statement is correct, arise on the occasion of a single experience of this nature. But the emotion of Power, as ordinarily understood, is not, I think, that which corresponds with an isolated experience of this nature, but is the feeling of capability in general—the feeling which corresponds with a cognised ability to bring about not this or that particular effect, but great effects generally. Such a cognition can, it is obvious, only come into being by the combination of numerous particular cognitions; and, similarly, the general feeling results from the aggregation of many particular feelings of the same nature. Each such cognition—normally gained by an actual experience of power exerted and effect produced—is accompanied by a minor degree of the feeling that we call Power, and the outcome of many such experiences will be a feeling abstracted from any particular experience, more frequently rising into consciousness, more decided and more voluminous, which will be the feeling that more usually goes by this name. Of all occasions on which an effect is produced on the environment, those will be attended with the most insignificant amount of exertion on the part of the organism which are produced vicariously,—that is to say, by others acting under the orders of the individual in whom the feeling occurs. In this way very great effects requiring the co-operation of numbers of men may be produced by an amount of exertion that is not only relatively but absolutely insignificant—by a word, a sign, a look. On such occasions the feeling of Power attains its maximum of intensity, and so great is the accession which the feeling gains in this way that the term is often used in substitution for the term Authority, which is properly only a particular case of Power.

The term Ease is somewhat ambiguous, in that it is applied not only, as many names of feeling are, to the corresponding phase of conduct—ease of execution—facility—which is the outward expression of the feeling here considered, but also to another phase of conduct, and through that to another feeling—that ease which is equivalent to *otium*. The context shows sufficiently clearly the sense in which the term is used here, a sense which, I think, is justifiable and convenient. The feeling occupies the same position towards that of Power that the feeling of Difficulty does towards that of Impotence.

The term Difficulty which is applied to the allied and contrary feeling is likewise ambiguous in that it is applied not only to the feeling which arises when considerable exertion is necessary to produce a given effect, but also to the circumstance in the environment which renders the exertion necessary. This ambiguity is not, however, likely to give rise to mistake. I am not sure that the term has been used before to connote the subjective state, but it seems to me undeniable that a distinct feeling arises in correspondence with the relation described, that this feeling lies between those of Power and Impotence, approaching nearer to the latter than to the former, and that it may fairly and appropriately be termed a feeling of Difficulty.

A more advanced stage of the action of the organism on the environment, and a more special relation between the two has now to be considered. An act of the organism is a movement for the achievement of an *end*. If the end is attained the act is successful: if not, it is a failure. The success or failure of an act is quite distinct from the effect produced on the environment by the act. The latter is an affair of quantity, the former concerns quality. If a man throws a stone at an object, the effect of his act, in the sense in which the word is used here, is the amount of movement imparted to the stone, and communicated to whatever the stone strikes; but the success or failure of the act depends on whether or no the stone strikes the particular object aimed at. The stone may be thrown a great distance with but little exertion and make a great smash by its fall, and in correspondence a feeling of Ease and even of Power may arise; yet, if it fails to hit the particular object aimed at, the act as a whole is a failure. For the feelings which attend success and failure in single acts no terms are more appropriate than the feelings of Success and of Failure, but for the feelings which correspond with the relation between these two phases of conduct, distinct names are in common use according well with the distinct character of the feelings.

TABLE X.

CLASS I. Sub-cl. II.: Self-conservative Emotions, Organismally-initiated.

Genus 7: Feelings corresponding with the relation of Success to Failure.

Successes are cognised as predominating over Failures.	in important matters.	Self-Reliance.
	in small matters.	Complacency.
Failures are cognised as predominating over Successes.	decidedly.	Depression.
	greatly.	Despondency.

With this genus is completed the examination of the feelings of Class I., and before passing on to the feelings of Class II., which correspond with interactions that affect the perpetuation of the race, it will be well to consider a few objections that may be made to the foregoing portion of the classification, and to indicate some cross-relationships that have been left unnoticed. To the feeling of Despondency has been assigned a place in the last genus of the second sub-class, while the feeling of Despair is placed in the first genus of the first sub-class; two feelings that are very closely akin are thus separated by the widest interval allowed by the limits of the Class. Feelings so similar as those of Failure and Defeat are as widely separated, and feelings of Gratification and Satisfaction, Hatred and Dislike, Fear and Alarm are placed in different genera. The classification may therefore seem open to the very objection that I have made to the classifications of my predecessors.

To such criticisms the reply is threefold, and when all the circumstances are considered the justification will, I trust, be found complete. In the first place, the names given to the feelings are necessarily more restricted in their meanings when used here than when employed in common discourse; and in restricting their meaning a certain neutral territory lying between two adjacent feelings, and usually ascribed indifferently to the one or the other, has been separated from both; and in this way the severance between two allied feelings has necessarily been made more complete by the clearer limitation of each of them. Then again it is to be remembered that this classification is based on the correspondence of feeling with action, and when actions approach one another in character the corresponding feelings must exhibit a similar alliance. It is true that Despair and Despondency have here a wide interval interposed between them although they are so closely akin; but consider the relations with which they correspond. If we turn back to the Tables in which they are described, we find that Despair is the feeling corresponding with the relation to the organism of an agent of overwhelming power with which it has unsuccessfully contended; while Despondency is the feeling corresponding with the preponderance of defeats over successes. Manifestly these two relations are closely allied in nature, and if the feelings corresponding with them were not also closely allied, the classification would indeed be open to destructive criticism. The same will be found true of the other couples of feelings instanced above. So far, however, the defence only shifts the objection a step further back. The rejoinder may at once be made: How is it that actions acknowledged to be so closely akin are placed so widely apart in the classification? The answer to this is the same that was given to a similar objection anticipated as offered to the arrangement of the Antagonistic feelings—the impossibility of representing in serial order relationships so intricate as those subsisting among the feelings. Manifestly we are here in the presence of a cross-relationship among the larger groups similar to those found to exist within the group of Antagonisms, and illustrated by the relations demonstrable in a diagram of three dimensions. The natural proximity of two feelings belonging to different groups may be well illustrated by the diagram of the tree already utilised. Just as we see two branches jutting in opposite directions from a trunk, divide, sub-divide, and spread until the outermost twigs of one interlace with the outermost twigs of the other, and the leaves of the two branches are in contact, so the outlying feelings of any great group may be expected, as they have been found, to approximate more or less closely to the outlying feelings of other groups.

CHAPTER XIV

CLASSIFICATION OF FEELINGS—*Continued*

REFERENCE to our Table of Classes in the first division of this Essay, will show that the Second great Class of feelings consists of *those which correspond with interactions between the organism and the environment that primarily affect the perpetuation of the race.*

The number of feelings included in Class II. is but small, but the group is extremely well characterised, and its importance is immense. Feelings of this Class are divisible according as they correspond with relations between the Sexes or with relations between Parent and Offspring. Since the former are the more fundamentally important, they may appropriately be termed *primary* and the latter *secondary.*

The *primary* feelings of this Class, or those that correspond with relations between the organism and the opposite Sex, are again divisible into those in which the correspondence is direct and those in which it is indirect, the former being the Sexual Sensations and the latter the Sexual Emotions.

The Sexual Emotions are three in number: Love, Jealousy and Modesty.

The emotion of Jealousy need not detain us, the circumstance which arouses it being of sufficiently obvious character; but some notice of Modesty is demanded by the fact that in origin it is the most obscure and inexplicable of all the feelings. Strictly speaking, Modesty can scarcely be called a feeling. That the name is correctly applied to a phase of conduct is manifest, but it is not so much itself a feeling as the tendency to a feeling. It is the tendency to embarrassment in sexual matters, Embarrassment being the feeling corresponding with the discovery by others of that which we wish to conceal. If we make an effort to rid ourselves of the familiarity of the notion, and try to look upon it as a fact new in our experience, it will appear extremely strange that the sexual function should be kept wrapped in a cloud of mystery of our own creation. In what circumstances Modesty had its origin it would be difficult even to conjecture, though there is little doubt that once initiated it has been preserved and intensified by sexual selection, which at first sight appears antagonistic to it. Fortunately, for our present purpose, the manner of its origin is not material. It is enough for us to recognise its existence, and to assign it a place among other feelings.

The *secondary* feelings of this Class correspond with the relations between the organism and its Offspring or Progenitors. They are the Filial and Parental feelings. What differences exist among them correspond with differences in the relations, as, for instance, that between paternal and maternal feeling. In one case only can the correspondence be said to be direct in the secondary group—the case of the feeling entertained by a mother to the infant at her breast, and in this case the feeling, like the interaction, is doubtless unique.

CLASS III.—*Feelings corresponding with interactions between the organism and the environment which primarily affect the common welfare.*

In Class I. we considered those interactions that concern the individual organism alone, looking upon it as an isolated being exposed to conditions that subserve or oppose its welfare. In Class II. we considered the conditions that influence the succession of organisms; and in the Class now under consideration we take account of the conditions that influence their coexistence. Man being a gregarious animal, all interactions between him and his environment have of course a twofold effect. If they directly affect the individual only, yet as he is a unit of a community they must indirectly through him affect the community of which he is a member. If they directly affect the whole community they must indirectly affect him as a member of it. But the distinction that we now have in view rests upon the bearing of the primary stress. Interactions of the first Class would affect the individual in precisely the same manner if he were an isolated being separated from all other individuals of his kind. Interactions of the second Class affect the individual as a member of his race. To an orphan celibate they have no existence, however intimate his other relations with his community, and the family-man would still experience them if he and his family were completely isolated from the rest of his kind. The interactions that we have now to consider affect the individual in virtue solely of his citizenship. They affect him not as an individual, but as a member of a society. Take away the society of which he forms part—leave him outstanding as an isolated individual—and the interactions become impossible; the feelings have no existence.

Communities, like individual organisms, have to struggle for their existence; and thus, in addition to the struggle for his own existence, each individual member of a community has to bear his share in the common conflict with the environment of the community; and with his relations to this wider environment a special group of feelings corresponds. Again, in his capacity of a member of a community, not only is the individual brought into relation to the environment of the community, but he is also brought into special relations to the community of which he forms a part. The society forms for him a special environment of itself—the social environmont; and with his relations to this environment another special group of feelings corresponds. Hence arises a division of this Class of feelings into two Orders—those which correspond with relations to the *environment of the community* (the Patriotic Feelings), and those which correspond with relations to the *community itself*—to the *social environment* (the Ethical Feelings). While the distinction between these two groups is clear, their inclusion in the same class is justified by a kinship so obvious that the patriotic feelings have often been included in the ethical. The sub-division of the Class is based partly on principles already utilised, and partly on variations peculiar to the new environmental conditions dealt with.

TABLE XI.

CLASS III. : Social-conservative Emotions. Order I. : Patriotic.

Genus 1 : Environmentally-initiated.

Feelings corresponding with the relation to the organism of an agent that is	noxious to the community.	Patriotic Aversion.
	beneficent to the community.	Piety.

Genus 2 : Organismally-initiated.

Feeling corresponding with the performance of an act on the environment of the community, for the benefit of the community.	Patriotism.

Of the feelings of this group Patriotic Aversion or National Hatred is the most widely and deeply felt; and the reason is obvious. As in the struggle for individual existence, so in the struggle for national existence the most frequent and most weighty experiences have been experiences of antagonism; and therefore the feelings of antagonism are the most deeply organised. In the case of patriotic feeling the shades and varieties of antagonistic emotion are far less numerous than in the case of individual antipathies, and again the reason is clear. The community as a whole is obnoxious to the attacks of comparatively few harmful agents, and the ways in which these agents can affect the community are uniform when compared with the variety and diversity of noxious influences to which the individual is exposed. Hence the number of possible relations in which noxious agents can stand to the community at large is much fewer than that in which such agents can stand to the individual. Then, too, the various relations in which a noxious agent can stand to an individual are not only numerous but are well-defined. The difference between a blow impending and a blow struck on the individual is plain, manifest and unmistakable. It is driven into consciousness by the most powerful and direct of methods. It does not admit of uncertainty. But a disaster impending upon the community and a disaster inflicted are by no means so readily distinguishable. The knowledge may be gained only by hearsay from doubtful informants, or may be gradually acquired by accumulated increments, or by shreds of knowledge gained here and there and patched together. Hence the group of tribal or national antagonisms does not admit of the same minute and detailed classification as can be made of the individual antagonisms. Nevertheless some varieties of the former are recognisable, and are based upon variations in the relation to the noxious agent similar to those of the latter, although they have not acquired sufficient prominence to gain special names. The feeling of antagonism with which a nation regards a hostile nation of approximately equal power is very different from the feeling which corresponds with the relation of a more powerful to a less powerful nation, and *vice versâ*; and the feeling of tribal or national subjection is very different from that which corresponds with conquest, although it has no nominal recognition.

If this definition of the feeling of Patriotic Aversion is correct, then, as the limits of the community become less definite and it merges more into surrounding communities, the feeling should merge and be lost in the ethical feelings; while, on the other hand, it should be strongest, other things being equal, where the boundaries between communities are most sharply defined. And this is found to be the case. It is notorious that the most intense examples of national hatred exist between the communities that are most isolated, and whose common boundaries are most sharply defined. In illustration may be mentioned the cases of insular peoples, of mountain-clans, and of races like the Jews and the Cagots who live mingled with other communities but sharply isolated from them. Here too we see one great reason of the pacific influence of commerce. It is not necessarily that the traveller or the resident in a foreign country learns to like or to respect his new neighbours; it is that he becomes a member of the foreign community, and so long as he remains a member of it he is directly interested in its welfare. In course of time the identity of interest teaches him to assimilate his adopted to his native nation, and to regard them as parts of a single community.

The feeling with which a national benefactor is regarded I have called Piety, reverting to an ancient meaning of the term. It is closely akin to Reverence, and although the latter feeling has already been classified elsewhere, a reference to the definition of it will show that there is no inconsistency involved in the arrangement. Reverence was defined as the feeling corresponding with the relation of the organism to an actively beneficent agent of greatly superior power. Now it is evident that an agent capable of directly affecting the whole community must be cognised as overwhelmingly powerful as compared with the organism; and if it affects the community beneficially, *a fortiori* it affects the individual beneficially; so that from this point of view Tribal Reverence or Piety is included in Reverence as a species in a genus. Here again we meet with an instance of the impossibility of representing all the complicated inter-relations of the feelings either in serial order or by any arrangement in a single plane. Were it worth while, it would not be difficult to show by another solid diagram the relations of feelings of the present to those of the previous Class.

The only feeling of this group that corresponds with an action initiated by the organism is Patriotism, a feeling which corresponds with an act undertaken on the common environment for the benefit of the community at large. The object with which the act is undertaken marks the limitation of the feeling. Whatever beneficent acts a man may do for any section of the community, however large, are not termed patriotic. If a man spends a million upon improved dwellings for the poor, we call him benevolent. If he wears out his life in labouring for the amelioration of class after class of his fellow-countrymen, we call him philanthropic or public-spirited. But we do not apply to his conduct the term Patriotic so long as his labours are for the good of a part or even of several or many parts of the community. Only when it concerns the welfare of the entire community does this term become applicable. Now the great majority of acts done for the benefit of the community as a whole consists in dealings with other communities, and the struggle for existence necessitates that, in dealing with other communities for the benefit of his own, the patriot has usually to deal with them antagonistically; and for this reason patriotic conduct is commonly understood to mean conduct antagonistic to some other community. But that this is not the sole nor the true meaning of the term will, I think, appear upon reflection; for nearly every one would admit the propriety of terming patriotic the conduct of a statesman who had devoted his life to the service of his country, even if he had never involved it in a war; and the self-sacrifice of a Curtius or a Winkelried is allowed to be a brilliant instance of patriotism, even though it harmed none but himself,

Order II. The Ethical Feelings: corresponding with such interactions between the organism and its *social environment* as affect the common welfare. This definition of the ethical feelings is novel, and its correctness is not immediately apparent, but I think it may be established. First note that in the absence of a social environment ethical feelings have no existence. If a man were entirely isolated from his kind and lived in total solitude, the terms right and wrong would not be applicable to his actions. If so applied they would have no meaning. According as his conduct tended to self-conservation or the reverse it might be termed prudent or imprudent, but a wicked or righteous act would be impossible. A wrong or wicked act must be an act that hurts some one; it may be more than this, but it must be this at least, and if there is no one to hurt, wrong and wickedness are impossible. Obversely, a right action must benefit some one. An act that benefits some one need not necessarily be a right act, but a right act must have this quality; and in the absence of any one to benefit there can be no rightness, in the ethical sense, in the act. It may be said that if an Alexander Selkirk were to gratuitously torture an animal, the act would be wrong; and this is manifestly true; but it is also true that we think it wrong because the sentient animal has come to be in a manner included in our social environment. To those whose social environment is more limited the act does not appear wrong; and as the ethical feelings become more and more developed wrongness is recognised in inflicting harm upon beings more and more distant in relationship from man, or rather this extension of the application of the stigma of wrongness is itself the expression of the development of ethical feeling. Development in another direction of the ethical feelings is marked by the less and less amounts of harm that are recognised as being wrong to inflict. I do not propose to discuss here the question of what we ought to call right and wrong. I merely take the facts as I find them; and, granting that these terms are applied to acts and classes of acts, I seek to define both the one and the other, to show under what conditions the terms right and wrong are as a matter of fact applied to them, and to discover the feelings that correspond with their various phases and varieties.

The method of regarding feelings as states in the organism corresponding with interactions between the organism and the environment seems to me to divest this perplexing subject of much of its difficulty. If we regard the Ethical Feelings as states corresponding with interactions between the organism and its social environment, the question arises, What special form can this interaction take that is different from the interactions between the organism and other sections of its environment? The community acts directly on the organism by punishment and reward—by chastisement, imprisonment and various other kinds of torture on the one hand, and by the bestowal of wealth, honours, power and other benefits on the other. But all these interactions can be suffered or attained—torture can be suffered and social eminence gained—not indeed in the absence of the community, but apart from its direct action; and the corresponding feelings—of Pain, Restraint, Authority, and so forth—as they correspond with other actions are included in other classes of feelings. The feelings of the present group are those which correspond with that additional element in the interaction which converts a pain into a punishment and a pleasure into a reward; they correspond with interactions that occur between the organism and its social environment and that cannot occur under any other circumstances. Although the community may and does act physically upon the organism, it is not the physical part of the action that the ethical feelings correspond with. It is with that feature of the community's action that we call Approbation or Reprobation.

These two attitudes of the community toward the individual are the special reactions that are evoked by the acts of the individual; and an act evokes the one or the other of these two reactions according as it is cognised to be noxious or beneficial to the community. When an individual acts in such a way as to benefit the community, he arouses in beholders an attitude of approbation. When he acts in such a way as to harm the community, he arouses in them an attitude of reprobation. These two attitudes of a community towards individual members of it are of course assumed in respect of patriotic and antipatriotic acts—those done on the environment of the community—as well as in respect of acts done on the community itself; but it is with the latter class of acts alone that we are now concerned.

Wrongful acts may be divided into two classes—those that wound the person or diminish the property of others, and those that wound the feelings. Every wrongful act must do one of these things, although many acts that do these things are not wrong; and the rightness or wrongness of a harmful act depends on whether the harm done to the individual is or is not exceeded by the benefit done to the community. If A wounds B, the act is viewed with reprobation—is considered wrong—not only by B, but by C, D, E, and other witnesses. Why is the act considered wrong by those who do not suffer from it? Because, as it seems to me, leaving Sympathy aside, each of these witnesses regards himself as possibly the next victim. Each of them grounds his judgment of the wrongness of the act, not on the fact of its perpetration on B in particular, but on its perpetration on a member of the community of which he himself is one. I do not say that this is the reason consciously alleged for the judgment. In most cases Reprobation, like other feelings, is felt and expressed without any analysis being made of the ground of its existence; but the reason that I have given, although not alleged, although perhaps not discovered on subsequent meditation, is yet the sub-conscious foundation for the judgment. Though it is not the avowed basis of our daily partition of acts into right and wrong, this is the avowed basis for the partition of them when occasion arises for a formal judgment to be pronounced; and explicit or implicit in every judicial decision is the proposition that the degree of rightness or wrongness of an act depends on the degree in which it is beneficial or noxious to the community. The jury decide whether or no the act was done, and by whom it was done. The judge sits as the representative of the community to determine the rightness or wrongness of acts. In forming his decision the principle by which he is guided is always the bearing of the act, not upon the person who chiefly suffers by it, but upon the community; or on the sufferer as representing the community.

This principle is formally embodied in the statute law. A steals an article from B. He is sentenced to a short term of imprisonment. On his release he steals an article from C. This time he is sentenced to a longer term of imprisonment. He is again liberated and steals another article from

D. He is now sentenced to penal servitude. He gets a ticket of leave and steals another article from E. He is sent back to penal servitude for a longer term. Why this progressive augmentation of the punishment? The articles are of approximately equal, or we will suppose of diminishing, value. The wrong done to E is not greater than that done to B. It may be much less. Why should it be visited by a penalty twenty or fifty times as severe? Obviously because the offences are looked upon not as isolated offences against individuals but as repetitions of the offence against the community. Still stronger evidence is afforded by the law. A prosecutes B for theft. B says he is sorry and A wishes to withdraw from the prosecution; but the magistrate refuses to allow the charge to be withdrawn. On what possible ground? Clearly because he looks upon the act of B as injury not to A only but to the whole community, and in his view A is no longer the party chiefly interested in the matter.

It is, as a rule, wrong to deprive people of their property without compensation, to injure or to kill; but there are many exceptions in civil life to these rules; and the exceptions are those occasions in which the harm done to the individual is, or is believed to be, more than balanced by the good done to the community. This it is that makes it right to fine the wrongdoer, to flog the garotter, and to hang the murderer. If it be said that the rectitude of such acts lies not in the balance of benefit which they secure to the community but in the infliction of a divinely-ordered punishment, then wherein lies the justification for destroying a house in order to prevent a fire from spreading, or in order to give a clear range to the artillery of a besieged town? and how can it be ethically permissible to imprison innocent people in quarantine? While as to most of these acts there is much controversy as to whether there is an excess of good done to the community over the harm done to the individual, no question is ever raised, save in the case of hanging, as to whether the action is right if this excess is shown to exist.

From a social point of view, acts may therefore be divided according as they benefit or harm the community or are indifferent. In the last case no feeling belonging to the present class is evoked in the beholders, but in the two former, feelings of Approbation and Reprobation respectively are aroused, and commonly find ready and well-understood expression. Each individual may not only experience these feelings towards others but may, under appropriate circumstances, himself be the object towards which the expressions are directed. His own acts may evoke these feelings in others; and with the relations thus formed between himself and his social environment special groups of feelings correspond. Of course the expression of approbation and reprobation is a physical process, and if such expression on the part of the community were necessary for the inception of the feeling, objection might perhaps be taken to this position. But it is not necessary. In this, as in previous cases, the feeling corresponds, not necessarily with the relation that actually exists, but with the relation that is cognised. Not only is the belief that one of these feelings exists in the community or the expectation that it will exist sufficient to arouse an ethical feeling, but the cognition that an act which is not and never can be known to the community, would if known excite either approbation or reprobation, is enough to arouse an ethical feeling.

Something more than this cognition is, however, necessary for the complete determination of the feeling. A martyr may go to the scaffold amid the unanimous execrations of the multitude, and yet not only be free from any corresponding feeling of Shame but experience an ecstatic rapture of triumphant Pride. Such an example appears enough to upset the whole hypothesis; but the discrepancy is apparent only. It admits of being conducted by a circuitous but secure route to a complete reconciliation. The circumstance in the environment which enters into the relation with which this group of feelings corresponds is, as has been said, not a physical occurrence but a feeling—the feeling of approbation or reprobation. As in all other cases of emotion, the circumstance must be known before the feeling can be aroused. But, for this circumstance to be known, the feeling of approbation or reprobation which is believed to exist in the community must be represented in the consciousness of the individual. This is the only way in which a feeling can be known; and unless the feeling is so represented and so cognised, the circumstance in the environment remaining unknown, its relation to the organism must remain unknown and the corresponding ethical feeling cannot occur. Now the individual is himself one of the community, and as such he regards acts with approval or the reverse. At first applied to the acts of others, these feelings by a natural process of transference become at length applied to his own acts; so that, when the feeling of approbation or reprobation cognised as existing in the community is represented in the mind of the individual, it comes into juxtaposition with the feeling of the same genus entertained by the individual towards himself; and according as these two feelings are of the same or of opposite signs, mathematically speaking, the ethical feeling which is their sum varies. This is what is meant by Desert. When the feeling cognised as existing in the community is of the same sign as that with which the individual regards his own act—when both attitudes are either approbative or reprobative—then the attitude of the community is cognised as *deserved*. When the signs are opposite—when the individual approves his act which the community reprobates, or when he disapproves his act which the community applauds—then the execration or applause of the community is cognised as *undeserved*. These different cognitions serve as bases for the differentiation of the ethical feelings.

TABLE XII.

Class III. : Social-conservative Emotions. Order II. : Ethical.

General Ethical Emotions.

The feeling corresponds with the relation of the organism, as a member of a community, to an act of one of the community cognised as	beneficial to the community.	Approbation.
	hurtful to the community.	Reprobation.

Particular Ethical Emotions.

Genus 1 : Environmentally-initiated.

The feeling corresponds with the approbation of the community toward the organism	which is expressed	and cognised as deserved.	Pride.
		and cognised as undeserved.	....
	which is not expressed but is cognised as deserved.		Dignity.
The feeling corresponds with the reprobation of the community toward the organism	which is expressed	and cognised as deserved.	Shame.
		and cognised as undeserved.	Martyrdom.
	which is not expressed but is cognised as deserved.		Remorse.

Genus 2 : Organismally-initiated.

The feeling corresponds with an action of the organism cognised as deserving	approbation.		Virtue.
	reprobation.	and liable to punishment.	Guilt.
		irrespective of such liability.	Repentance.
The feeling corresponds with an action of the organism whose neglect is cognised as deserving reprobation	and as liable to punishment.		Duty.
	and as not liable to punishment.		Honour.

Of the definitions in the foregoing Table, that of Pride will probably be allowed to be correct. People are not said to be proud of a quality or a possession, unless it is one which is looked on with approbation by the community. A person who exhibits in his demeanour an appreciation of himself which is considerably above that in which he is held by his neighbours is not called proud. He is called conceited. But if among strangers he behaves so as, without claiming admiration, to convey an impression that he is not unconscious of his own merit, he is termed dignified. The feeling that is placed between Dignity and Pride, and which is defined in the Table, is a very definite feeling and one that has been made familiar to us by writers of fiction—a conspicuous example being depicted in the *Scarlet Letter*—but it has received no name. It is closely allied to Remorse, and the definitions will show the nature as well as the closeness of the kinship. The definitions of Guilt and of Repentance will probably be allowed to be correct. The retrospectiveness of the latter feeling and the infusion of Regret that it contains are two sides of the same fact, as will be seen by referring to the definition of Regret. The distinction that I have drawn between Duty and Honour appears thoroughly maintainable. We do not speak of an act as a duty unless we think that neglect of it ought to be punished, and every such act is certainly called a duty. On the other hand, when we say that a man should do this or that from a sense of honour, it is implied that there are no other means of making him do it if this motive fails. A man of a nice sense of honour is one who is punctilious in doing things which he could not be punished for neglecting, and whose neglect would arouse but little disapprobation.

The special methods by which the community reacts upon its individuals have already been noticed. These methods are reward and punishment, both of which may be included under the head of Award. Reward is the special reaction of the community to acts that are beneficial to it, punishment its reaction to noxious acts. As in physics action and reaction are equal, so in ethics the amount of reward or punishment is proportioned to the degree of beneficence or noxiousness of the action borne by the community. Here we meet with another meaning of the word Desert,—a connotation which gives to it a quantitative value in addition to the qualitative value previously affixed to it. Not only is punishment looked on by the individual as deserved when and when alone it is inflicted in retaliation for a noxious act, but the amount of the punishment must be proportionate to the noxiousness of the act before one can say that an offender has got his deserts. Similarly the amount of a reward must be proportionate to the beneficence of the act for which it is given, or it will not be considered as completely deserved. The relation between the quality of the act and the amount of the award cannot be accurately fixed, for neither the one nor the other admits of exact measurement. But still a certain proportion there must always be, and the more closely proportionate the award is to the action that calls it forth, the more appropriate is it considered. With relations of the reactions of the community upon beneficent and noxious individuals a small but well characterised group of feelings corresponds.

TABLE XIII.

CLASS III. : Social-conservative Emotions. Order II. : Ethical.

Feelings corresponding with the relation of Award to Desert.

The feeling corresponds with a relation between award and desert which is cognised as one of	equality.		Justice.
	inequality	moderate.	Injustice.
		extreme.	Indignation.

The term unjust is commonly applied to punishments in excess of desert, but this is merely because such cases of injustice are more common than others. A few examples will show that it is equally applicable whenever award is disproportionate to desert, whether the reaction of the community is unduly favourable or unduly unfavourable to the individual. When we read that a man has got a long term of imprisonment for picking up a dead rabbit or for stealing a few turnips, we estimate the punishment as excessive, and we have a feeling of Injustice. But the same feeling arises in not inferior volume when we hear of a man getting a few weeks' imprisonment for a murderous assault upon his wife. Here the punishment is estimated as insufficient compared with desert, and the feeling of Injustice arises on the cognition of an inequality opposite in sense to that of the previous case. A short time ago a railway porter found a parcel containing negotiable documents to the value of several thousands of pounds, and restored it intact to its owner, who rewarded him with a threepenny-piece. Knowledge of this incident at once arouses a feeling of Injustice, although the question of punishment is not involved in it at all. It is the disproportion between reward and desert that gives occasion for the feeling. Lastly, when this disproportion is in the form of an excess of reward over desert the same feeling arises; as, for instance, when cases of nepotism and favouritism come to our knowledge.

If this definition of Injustice is admitted, the definition of Indignation will also, I think, be allowed, for the latter is always due to the cognition of a great injustice; and such a cognition never fails to arouse the feeling. Provided the inequality between award and desert is great, it matters not whether it is reward or punishment that is involved, nor whether these are lacking or excessive. We are as indignant at a gross example of favouritism as at a gross instance of ingratitude, and experience the same volume and intensity of feeling when a Napoleon III. attains power by a mass of crimes, as when a negro girl is flogged to death for disobedience by a missionary.

Class IV.—*Feelings corresponding with interactions between the organism and the environment that primarily affect the welfare of others.*

In this Class is reached the extreme limit of application of the term interaction, and but for the sake of uniformity it would be better to substitute the term relation. The feelings of this Class have a close kinship with those of the last Class, but the difference in their evoking circumstances will appear sufficient to justify the separation. The sub-division proceeds on similar grounds to that of previous Classes.

TABLE XIV.

Class IV.: The Sympathetic Feelings.

Genus 1: Environmentally-initiated.

The feeling corresponds with the relation to the organism	of an accession to the welfare of others	which is cognised as equally deserved by the organism.	Envy.
		which is not compared with that of the organism.	Gratulation.
	of a diminution of the welfare of others	which is moderate.	Sympathy.
		which is extreme.	Pity.

Genus 2: Organismally-initiated.

The feeling corresponds with the performance of an act for the benefit of others.	Benevolence.

My definition of the nature of Envy may be regarded as unduly cynical, but I think it will hold good. That an accession to the welfare of others which is cognised as equally deserved by himself, should always and by every one be looked on with Envy, appears horrible, but I fear it is true. Doubtless not every such accession, even though it might justly be cognised as equally deserved by himself, does actually arouse envious feelings in the beholder, but this is because the cognition is either not formed, or not attended to, or thrust out of sight. So long as the cognition is formed and is allowed prominence in the mind, so long the feeling of Envy is and must be experienced. Gratulation is the feeling of which congratulation is the expression. The other feelings of this Class do not require comment.

CLASS V.—*Feelings corresponding with interactions between the organism and the environment that are neither conservative nor destructive.*

From the nature of its limitation this Class of feelings is necessarily somewhat heterogeneous. It is a residuum, comprising all the feelings that are not included in the other Classes ; but its components have nevertheless a relationship sufficiently obvious to have gained very general recognition, and such a relationship existing in a Class so constituted speaks strongly for the naturalness of the whole classification. The primary division is according to the mode of initiation.

Environmentally-initiated feelings of this Class are divided, on lines similar to those previously laid down, into those which correspond with the relation of the organism to an agent in the environment and those which correspond with its relation to an event. In addition there are in this Class two groups that have no analogues in previous Classes :— feelings corresponding with the relation of the reaction of the organism to the action of the environment, and feelings corresponding with the relation of the organism to the unknown.

TABLE XV.

Class V.: Feelings corresponding with interactions between the organism and the environment that are neither conservative nor destructive.

	Order I.: Environmentally-initiated.	
Genus 1.	The feeling corresponds with the relation to the organism of an *agent* in the environment cognised as neither beneficent nor noxious.	Feelings of Admiration.
Genus 2.	The feeling corresponds with the relation to the organism of an *event* in the environment cognised as neither beneficent nor noxious.	Feelings of Surprise.
Genus 3.	The feeling corresponds with the relation of the reaction of the organism to the action of the environment.	Æsthetic Feelings.
Genus 4.	The feeling corresponds with the relation of the organism to the unknown.	Religious Feeling.
	Order II.: Organismally-initiated.	
Genus 5.	The feeling corresponds with an action of the organism undertaken for no immediate beneficial end, but to employ surplus activity.	Feelings of Recreation.

Genus 1. The only agent in the environment which can arouse a feeling belonging to the present Genus is an agent which is, or is cognised as, neutral so far as the welfare of the organism is concerned. But no such agent will attract attention—will arouse any feeling at all—unless it is forced as it were upon the notice of the individual by its exceptional prominence. Agents that directly affect the welfare of the organism are as a rule recognised with great readiness and certainty, but those that are indifferent will not arouse notice unless they are of considerable power or unless their power is exerted in a conspicuous manner. Further, it is evident that if the power of the agent is not very great it must be conspicuously exerted in order to attract notice, while if it is very great indeed it may arouse attention even if not exerted at all. According to the magnitude of the power attributed to the agent will be the sub-division of this group of feelings.

TABLE XVI.

CLASS V. Order I. Genus 1: Feelings of Admiration.

Feelings corresponding with the relation to the organism of an agent in the environment which is cognised as neutral	and of overwhelming power	which is exerted.	Awe.
		which is not exerted.	Sublimity.
	and of greatly superior power.		Majesty.
	and of superior power.		Admiration.
	and of approximately equal power.		Respect.
	and of insignificant power.		Curiosity.

Awe and Sublimity are not commonly separated by the distinction drawn in the Table, but the division appears to me not only useful but to a certain extent implicit in the commonly received acceptation of the terms. For the feeling of Awe has an undoubted kinship to Terror. It contains a slight infusion of Fear. Now when an agent of overwhelming power is in action—is exerting its power—however distant or neutral the agent may be, we cannot avoid a certain cognition, however faint, of the possible application of this power to ourselves. If the agent, however powerful, is cognised as passive, this idea of its application to the organism is so far in the background as not sensibly to affect the feeling aroused; but when the power is exerted the concept rises more toward the full light of consciousness, and gives a slight but decided colour to the feeling.

The feelings of Majesty and Admiration depend on the cognition of agents whose power is cognised as superior to that of the organism but not overwhelming. As the agent which evokes a feeling of Admiration is inferior in power to one which evokes a feeling of Majesty, its action must be more conspicuously displayed; and this I think will be admitted to be the case. The term Majesty, like the names of many other feelings, is given not only to the feeling, but is also ascribed to the agent as a quality; and thus used it denotes the special environmental circumstance that arouses the feeling. Now when Majesty is used to denote a quality it connotes deliberateness of action—implies greatness of mass moving rather than velocity of movement; and a large mass moving slowly gives the idea of much greater power than a small mass moving quickly, even when the momenta are equal, because we estimate power in environmental agents in terms of our effort, and our limbs being levers of the third order, it is much easier for us to move a small mass quickly than a large mass slowly.

As the power of the agent diminishes, the conspicuousness with which it is exerted must increase or it will not be cognised. Hence to produce a feeling of Admiration power must be more conspicuously exerted than to produce one of Majesty, and to evoke the feeling of Respect the display must be more conspicuous still. For this reason Respect is not commonly felt unless the power of the agent has been displayed repeatedly. We do not respect a person on casual acquaintance. It usually requires a somewhat prolonged knowledge to evoke this feeling; and where Respect is felt upon a short acquaintance, it is owing to the exceptional conspicuousness of the display of power, as, for instance, when Respect is felt for a tenacious adversary. In such a case it may be said that since an adversary must be a noxious agent, the feeling ought to be included in Class I. But an adversary is not necessarily noxious. He may be our adversary at chess or whist, and we may respect him in so far as he is a chess or a whist player without extending respect to his general character. The difference between magnitude of power and conspicuousness of its display is well seen in the same instance, for we respect an adversary even inferior to ourselves if not much inferior, but we do not admire him unless he is considerably our superior.

Genus 2. What is true of a neutral agent is true of a neutral event: it will not attract notice unless it is forced, as it were, upon the notice of the individual by its exceptional prominence. An event may be conspicuous in two ways—by its incongruity with previous events, or by its suddenness. If it owes its prominence to its incongruity with the previous experience of the organism, the feeling aroused is so intimately blended with this cognition of incongruity that it may best be considered as belonging to the next Class, this being the point at which the feelings of these two Classes become continuous. The only remaining case in which an event neither noxious nor beneficent is prominent enough to arouse a feeling is when it owes its prominence to its suddenness; and the feeling aroused by the cognition of a sudden event is a feeling of Surprise.

Genus 3. Æsthetic Feeling has been defined as the relation which the reaction of the organism bears to actions on it of the environment which are neither conservative nor destructive. Shortly after arriving at this conclusion I found that I had unwittingly been treading closely in the footsteps of Mr. Grant Allen, of whose charming book, *Physiological Æsthetics*, a very similar principle forms the basis. This unexpected coincidence is to me extremely satisfactory, since it raises a very strong presumption of the approximate correctness of this view of the nature of Æsthetic. On reading Mr. Grant Allen's work I was strongly disposed to discard my own view in favour of his, and to regard the feeling of Beauty as corresponding with the maximum of stimulation with the minimum of fatigue or of waste; but after some hesitation I have thought it better to retain the view which regards it as the maximum of action of the environment on the organism with the minimum of reaction of the organism on the environment. Although the correctness of this expression is not nearly so evident as that of Mr. Allen's, it is not only more in harmony with the system of classification here expanded, but it brings into prominence elements which I believe to be equally in accordance with truth and of more fundamental character. Stimulation, it is manifest, can only occur by an action of the environment on the organism. It is not at first sight equally manifest that fatigue necessarily implies action of the organism on the environment; but it will be admitted that it usually does so, and I think it can be shown that it always does. Fatigue as commonly used means the feeling that accompanies exhaustion of muscular power after exertion,—that is to say, it implies much previous action on the environment. But we speak also of fatigue of the eyes after working long at the microscope, or after many hours in a picture-gallery. In the former case there is true fatigue —exhaustion of the ocular muscles, and this may also be present to a certain extent in the latter—but the feeling here is not mainly, I think, one of true fatigue; it is mainly a feeling of satiety. There is, however, another application of the term fatigue which must be admitted to be correct, and which appears at first sight to have no reference to muscular action—to reaction on the environment. This is the feeling that follows continued intellectual exertion. When this feeling is present there may have been no preceding muscular exertion. The body may have been in complete repose with reference to its surroundings. Yet there has been great internal activity, and there is a considerable volume of feeling to which the term fatigue is universally applied. Can this feeling be said to correspond with action of the organism on the environment? If by correspondence is meant direct correspondence, of course it cannot; but if the correspondence is to be thus restricted, neither can fatigue of the muscles of the eye and ear be said to correspond with such action. Intellectual exertion is on the physical side the opening up of new elements—the rendering permeable of new tracts—for the currents or waves of molecular movement in the cerebral cortex. Every conclusion reached, every judgment formed, every similarity perceived, every difference distinguished, implies a modification of the structure of the brain—implies a redistribution of the resistance to molecular change—implies a modification in the direction that future changes must follow. But the cerebral cortex, regarded physiologically, represents combinations of muscular movements; and a modification of the structure of the cerebral cortex is, on the physiological side, a modification in the grouping of muscular movements—is a modification of the way in which the organism acts upon the environment. Now if we bring together the first and last links in this chain of reasoning we find that intellectual exertion necessarily implies a modification of the action of the organism on the environment, and that the fatigue which follows great intellectual exertion is the feeling which corresponds indirectly with a modification of the action of the organism on the environment. Mr. Grant Allen has so carefully, and I think thoroughly, established his principle that there is no necessity to contend at length and in detail for the correctness of the similar expression which is here substituted for it.

Genus 4. We have now dealt with every relation to the organism of those surroundings that are special to the individual, and of those more extended circumstances to which he is related as a member of a race and of a community—to all those surroundings that can be cognised with any approach to accuracy. These special environments are different for each community and for each individual, but, however wide they may be, they include of necessity that which is known and that only. Outside and beyond these limited spheres of interaction there lies the limitless Unknown, with which the organism comes into relation at countless points of contact. The Religious Emotion is that state in the organism which corresponds with the aggregate of these relations to the unknown—with the relation to it of the cosmos outside of the environment. It is impossible to deal within the limits of this book with all the aspects, many of them highly controversial, of this large subject. To do so would require a separate essay. I will therefore merely set down the view I take of the matter for the purpose of classification, without entering upon any defence or lengthened discussion. By the unknown I do not mean that which is not definitely known. I mean that which appears to be outside the sequence of physical causation. To use a somewhat discredited term, it is that which appears to the individual not only unknown but unknowable. It is evident that all acts of the organism are regulated by relations with the known. Even in dealings with the unknown we regulate our acts on the assumption of the uniformity of nature—on the assumption that the same general relations that hold good in the sphere of the known hold good in the sphere of the unknown also,—that is to say, practically our acts are regulated by relations with the known. Where we have to deal with matters to which the uniformity of nature as we know it does not apply, there we enter the sphere of the unknown, and then those feelings arise which we term religious. If this is so, then it is evident that what may be termed the provocation or eliciting circumstances of the religious emotions will differ widely with different individuals, and still more widely with different communities. The savage, for whom the uniformity of nature, or the necessary sequence of physical cause and effect, has no existence outside of the changes produced by living animals, attributes every event which he cannot ascribe to the direct action of a known living agent to the direct action of an unknown living agent—to a supernatural agent. Thus every such event brings him into relation with the unknown and arouses in him a feeling which must be called rudimentarily religious. As knowledge increases, the luminous sphere of the known continually expands and encroaches upon the outer darkness of the unknown, and as the latter is pushed back, the relation with which the religious emotion corresponds become more and more remote from the common surroundings of daily life. As acquaintance with the uniformity of physical causation extends, the circumstances that arouse the religious emotion become more and more remote from concrete experiences. At first it extends to almost all surrounding phenomena, to the flow of water, the movement of the breeze, the course of the heavenly bodies, and even the occurrence of bodily accidents—stumbles and falls. In semi-civilised men it is only the rarer and less accountable of such actions that arouse the emotion. No longer aroused by the flow of the river or the variation of the tides, it still occurs upon the sight of a water-spout. After winds have been accounted for by varying atmospheric pressure and fluid-elasticity, and rain by the capacity of air under different conditions to hold water in suspension, a stroke of lightning is still attributed to the personal intervention of the Deity, and a season of drought is still provided against by prayers for rain. After the course of a fever is attributed to the action of strictly natural laws, the occurrence of an epidemic is still considered as a punishment inflicted by an angry God upon His disobedient creatures. As knowledge increases these inconsistencies disappear. All physical phenomena are included in one unvarying sequence of physical causation. The whole universe of space and time comes to be included in the luminous sphere of the known; but, however large this sphere, it is still bounded over its entire surface by the immense unknown, and what the evoking circumstances of the religious emotion lose in proximity they more than gain in volume. The analogy of the sphere, whose surface increases as the square of its radius, will help us to understand how vastly the aggregate of these circumstances will exceed in the case of a man of culture and intelligence those which environ the uncultured man.

Genus 5. The feelings of Recreation are, as Mr. Grant Allen has pointed out, closely allied to the Æsthetic feelings, and the definitions given in Table XV. show what appears to me to be the nature of the kinship. The first need of the organism is to conserve itself, and until this need is satisfied none of its energies can be diverted to any other purpose. Its second need is to provide for those that are dependent on it. The third, which is often involved in the other two, is to take its share in the conservation of the community. Only when these needs are satisfied can activities of the present Class come legitimately into existence, and only then can the feeling be experienced. If, after all these needs are satisfied, there remain a surplus of energy available for expenditure in other directions, then, in whatever direction such energy may be expended, the corresponding feeling partakes of the character of Recreation. If, however, the other needs are of such an engrossing character as to absorb all the available energy of the organism, then recreative activity becomes impossible, and the feelings of Recreation have no existence. It is obvious that the meaning of the term Recreation as here used is more extensive than its ordinary acceptation, since it includes not only those forms of activity that are known as games and sports, not only music and art, but all social pleasures and all those occupations that belong to the amateur.

In closing the consideration of this Class of feelings, it will be appropriate to point out that although it has the least internal cohesion of any of the Classes, yet the kinship of the several genera to one another is not only well marked but is generally recognised. The affinity between the Sublime and the Beautiful had existed as a betrothal long before Burke's essay irrevocably joined them. Beauty is so naturally associated with Admiration that the one can scarcely occur without the other, while great Beauty needs but the additional element of Surprise to elevate it into Rapture. The association of Æsthetic with Recreation is too trite to require more than bare mention; and the kinship of the Religious emotion with Awe and Sublimity is not less obvious that its close fundamental relationship with Æsthetic in all its forms, whether of architecture, of painting, of music, of sculpture, of costume or of ceremonial.

Class VI.—*Feelings which correspond with the relation between interactions.*

These are the Feelings of Cognition. The meaning of this somewhat paradoxical expression has already been explained. A cognition is itself a feeling—the feeling accompanying the transition from one prominent state of consciousness to a similar adjacent state. Every cognition has therefore an aspect as feeling, and, when viewed from this standpoint, cognitions are susceptible of a classification quite different from that on which they are arranged when viewed solely on their cognitive aspect, though still based on variations in the correspondence between the organism and the environment. A cognition, viewed solely as a cognition, is a relation in the organism corresponding with a relation in the environment. Viewed as a feeling it is the state in the organism which corresponds with a relation between the organism and the environment. We have to determine what this relation is.

Every cognition, says Mr. Spencer, is a recognition. In other words, it is an assimilation of a new experience with previous experiences; or, translated into terms of that aspect of the correspondence between the organism and the environment with which we are now dealing, it is the state in the organism which corresponds with the relation between the present experience and past experiences—between the present interaction and past interactions. Now the assimilation of a present experience with past experiences depends on its congruity and conformity with them. If it is completely congruous it is completely assimilated, if completely incongruous it is not assimilated. Hence the divisions of the feelings of cognition depend on the congruity that is cognised between present and past experiences.

TABLE XVII.

CLASS VI.: The Feelings of Cognition.

A cognition of complete congruity is on its obverse aspect a feeling of	Conviction.
A cognition of general congruity is on its obverse aspect a feeling of	Belief.
A cognition of incongruity is on its obverse aspect, according to the degree of incongruity, a feeling of	Wonder. Astonishment. Marvelling. Amazement.
A cognition of multiformity of experiences is on its obverse aspect a feeling of	Perplexity.
A cognition of contrariety of experiences is on its obverse aspect a feeling of	Doubt.
Repeated cognitions of contrariety induce a proneness to doubt which is	Scepticism.
A cognition of an experience contradictory of previous experiences is on its obverse aspect a feeling of	Disbelief.
A cognition of the juxtaposition of an experience to a previous experience with which it is incongruous, and in comparison with which it is of insignificant magnitude, is on its obverse aspect a feeling of	Ludicrousness.

There is not much that calls for notice in the preceding Table. It will be noticed that Surprise has been placed in a different Class from Wonder and Astonishment, closely as these feelings must be admitted to be allied. Surprise, it will be remembered, depends on the suddenness of the event that calls it forth. It is true that when we meet a person in the street whom we had believed to be far away, we say "I am surprised to see you here," and that this expression is used quite apart from the suddenness of the meeting. We may perceive him a hundred yards off, and the certain identification of him may extend over several minutes, and still we say we are surprised. This discrepancy between my statement and common usage depends, I think, on the circumstance already alluded to, that people are in general very lax and unprecise in their application of names to states of feeling, and do not commonly distinguish clearly between feelings that are at all closely related. I should consider it incorrect to use the term surprise in the case instanced. The expression should be "I *wonder* to see you here," and every one will admit that this expression would be appropriate. Which of the two terms is eventually chosen depends on the usage and is of little importance. What is important to remember is that the *magnitude* of a change in the environment and the *suddenness* with which it occurs are two totally different circumstances, and that the feeling aroused by the one is different from the feeling aroused by the other. What names we apply to the two feelings is immaterial so long as we remember that the feelings are different. The definition of Ludicrousness is an adaptation from Mr. Spencer's views. It harmonises well with this method of classification.

After all that has gone before, it will not be necessary to examine and defend separately each of the definitions in Table XVII. Any one who has read the previous parts of the Classification will anticipate the nature of the defence that I should make, and will by this time have made up his mind whether to accept or reject the basis on which the Classification is founded. If he is able to accept it, it will be enough to have shown him that every group of feelings is susceptible of classification upon that basis, and the actual position of any individual feeling is a matter of secondary importance. If, on the other hand, the principle of the Classification does not find acceptance, then it is useless and profitless to haggle about its details.

The Classification that is here proposed does not lay claim to finality. It is a characteristic of all classifications founded on the principle of Evolution that they admit, they proclaim, the artificiality of all abrupt limitations. If all things have arisen by modification of preceding things, there may be wide differences but there cannot be abrupt differences. Where two things or two groups of things are connected by a graduated series of intermediate forms, all may agree that the two should be separated, but the precise link at which the graduated chain is to be severed will surely arouse differences of opinion. Such differences are often important, but they do not invalidate the main principle involved—the existence of a distinction between the two groups. All that is claimed for this Classification is that it is founded on the principle of Evolution; that it harmonises with Mr. Spencer's System of Psychology, of which it is indeed an extension and a corollary; that it indicates the relations of each feeling not only to its two nearest neighbours, as only an arrangement in serial order can do, but to many adjacent feelings which approach it on many sides; that it affords a place for Will, nay, that without Will it would be incomplete; and finally, if I may venture a prediction, that it will be found elastic enough to include any feelings that may have been omitted from this enumeration.

CONCLUSION

The three divisions of our subject-matter—Nervous Process, Conduct and Mind—as laid down in the Introduction, have now been separately examined and described. It remains to bring them together and to twist into one cord these ravelled strands. It has become obvious in the course of our investigation that the nervous process is the central factor which underlies the other two. Without nervous process there can be no conduct. Without nervous process there is, so far as we know, no mind. The association, or rather, the consequence of conduct on nervous process is a purely physical affair, and might, so far as we know, proceed equally well in the absence of mind. As a matter of fact in various abnormal states, and especially in post-epileptic occurrences, conduct does proceed while mind is almost or entirely absent. The mental factor which is of supreme importance with regard to conduct is pain. It seems most probable that consciousness first came into being through pain; that it was in the race the first conscious experience as it is in the individual the first and the last. Save that small portion which is devoted to the pursuit of pleasure, virtually the whole of our conduct is absorbed in defence against and avoidance of pain. The significance of pain is that it is the equivalent in consciousness of some action which is tending to destroy the organism, and it is difficult to evade the impression that its origin and persistence are due to its giving a readier and more effectual warning to the whole organism of destructive agents affecting any part than any material process could. Until it had attained intelligence enough to foresee the effects of acts, no organism would make any effort to avoid disintegration, if disintegration were unattended with pain. Given an organism endowed with potential activity, then the direction that this activity shall take is determined by the attraction of pleasure and the repulsion of pain. The organism moves in that line of least resistance in which pleasure is greatest and pain least.

The question of what the variations are in nervous process which accompany and underlie variations in mental state, is a problem as full of difficulty as it is of interest. Our knowledge does not at present admit of a solution in detail, but certain broad principles may be regarded as well-nigh substantiated.

Feeling being a state in the organism, which arises whenever the organism acts or is acted on, it is natural to suppose with Mr. Spencer that the nervous process which underlies feeling is the process by means of which we act, and which is evoked when we are acted on. This process is a nervous discharge. A distinction has been drawn (Chapter I.) between the nervous discharge as it is emitted explosively from cells, and the discharge as it is merely travelling in the fibres. It is the first of these with which we suppose feeling to correspond. An impression is made on the organism, *e.g.*, we kick against a stone. At once a current of force is started from the foot towards the brain. But while this current is travelling we feel no pain. We feel the jar of the shock at once, but the pain we do not feel for a second or two. The explanation is, that for the feeling of impact to occur, a slight and local discharge is sufficient, and this slight and local discharge is immediately set up by the arrival of the current from the smitten toe; but for pain to occur, there must be a general and widespread discharge, and for such a discharge to occur the impulse must be diffused, and this diffusion of the impulse occupies time. That the impulse is diffused and the discharge widespread is not a mere conjecture. It is supported by evidence. For what do we find when pain occurs? We find the leg drawn up, the features contracted, general contortions, a sweating skin; all evidences of widespread discharge.

The amount of discharge evoked depends on the amount of impression made on the organism, and the amount of feeling corresponds with the amount of discharge evoked. Hence the volume of the feeling corresponds with the voluminousness of the impression made on the organism. Similarly, the greater the part of the organism directly engaged in any act, the greater the initiating discharge, and the greater the volume of feeling accompanying the act. Again the more intense the impression the more intense the discharge, and the more intense the feeling.

We have seen that a discharge beginning on the surface of the brain may spread in area, or may increase in intensity, or may extend in depth. The spread in area and the increase in intensity of the discharge have their corresponding variations in the volume and intensity of the feeling. For instance, on putting the hand into cold water, the local impression sets up a localised discharge, and we have a feeling of local cold, the intensity of which depends on the temperature of the water—that is, of the impression on the skin. On going out into the cold air at night, the much greater area of impression produces a much greater area of discharge, and correspondingly a much more voluminous feeling arises. Here again the intensity of the feeling corresponds with the intensity of the discharge. There is no new element in the impression save that of extended area; there is no new element in the discharge save that of wider spread; and there is no new element in the feeling save that of greater volume. But suppose that the exit into the night air is that of a wife who is turned out of doors by her husband. The impression on the organism is now not only that of the temperature. There are aroused in faint intensity, but in overwhelming volume, the faint discharges corresponding with innumerable past impressions of ill-treatment, and other discharges corresponding with innumerable anticipations of future suffering. The result of the combined action of all these initiating discharges is a tempestuous explosion of nerve elements, extending not only in area over the surface, and in intensity in the superficial regions, but also in depth. There is an universal turmoil throughout all the nervous regions from the highest to the lowest. And corresponding with this universal turmoil, with this extension of the discharge in a new direction, there is a new element in the feeling, so that in place of a sensation there is now an emotion. The physiological substratum of an emotion differs therefore from that of a sensation in this, that while the latter affects strongly centres of the highest order only, the former strongly affects centres of all orders. Let us see if there is any corroboration of this doctrine.

If the physiological substratum of a sensation is in the highest nervous regions only, then when these highest nervous regions are acting feebly or not at all, the impression that ordinarily arouses a sensation will arouse either a feeble sensation or none at all. In sleep the highest nervous regions are acting feebly or are inactive, according to the profoundness of the slumber; and impressions made during sleep arouse feeble sensations or none. In *petit mal* the highest nervous regions are altogether inactive; and in *petit mal* impressions are unfelt.

Again, if the physiological substratum of an emotion is a nervous discharge beginning in the highest nervous regions, and spreading thence throughout the hierarchy, then the outward expression of an emotion will begin in the most peripheral regions and spread towards the centre. And we find that in humorous emotion, first the lips extend into a smile, then the mouth opens, then voice is produced by contraction of glottis, then head is thrown back, and lastly, ribs and diaphragm are brought into play, and produce a hearty laugh. So in weeping, we see first retraction of the lips and wrinkling of the forehead, then closure of eyes and opening of mouth, then production of voice, and lastly, the convulsive action of chest and diaphragm in sobbing. So in anger, there is first frowning and protrusion of lips, then closure of jaws, then clenching of fists, raising of arms, elevation of shoulders, retraction of head, and general stiffening of the trunk.

Since feeling is the mental accompaniment of the discharge from nerve-cells, it is natural to suppose that thought, the remaining factor of mind, is the accompaniment of the remaining factor of nervous action,—that is to say, of the current in the fibres.

Thought is a relation between feelings, and a relation between feelings can be established only when the feelings are brought into proximity—when they occur in rapid succession. For two feelings to occur in rapid succession there must be two discharges of groups of cells in rapid succession, and it has been shown how the successive discharge of two separate regions is accompanied by a draught or current of nerve-energy from the one region to the other. It is this current that is the physiological substratum of a thought. When the thought is simple, the current is single. When the thought is complex, the current flows in a leash of channels. When the relation between the feelings is established for the first time, the draught of energy forces for itself a passage through the ground-substance of the gray matter in the manner that has been indicated in a previous chapter. When a passage has once been opened through the ground-substance, it remains permeable; or, at any rate, the ground-substance is more permeable in that direction than it was before; and correspondingly we find that when a thought has once been conceived—when a new way of looking at things has once occurred to one; when a new analogy has been discovered; when a new application of a law has been made; when a problem has once been solved—the new thought remains as a part of the mental furniture of the individual. It can always be repeated with far greater ease than it was originally conceived. With each subsequent passage of a current through a track in the ground-substance that has been traversed before, the track becomes more permeable. The poles of the molecules are by each discharge shifted more and more into parallelism, the track becomes clearer, wider, and more easily traversable. And similarly with every repetition of a mental operation, the operation becomes readier and more rapid. Each repetition of the words of a play helps to fix them in the memory. Each repetition of a new melody renders its execution more certain. Just as each repetition of an act of any kind—of an operation of handicraft, a stroke at billiards, an operation of war, a construction of a ship, a management of a business—renders subsequent acts more facile; so every repetition of a mental operation, whether the steps in a geometrical problem, the determination of the atomic weight of a metal, the invention of a new process of dyeing or measuring, or what not, renders subsequent similar operations easier.

It is to be noticed that as mental operations are repeated more often, and as they become easier, so do we become less vividly conscious of them. The first time we solve a problem, the first time we lift our eyes from the book and repeat the words from memory, the first time we devise a new way of dealing with circumstances, we are intensely conscious of the affair. Our whole attention is directed to it. The sense of effort is great. The whole mind is absorbed in the work. But with each repetition of the operation, as it becomes easier, readier, and more rapid, it also becomes less conscious. After a time the steps of the problem and its solution occur to the mind spontaneously and without searching for. After a time the words of the play rise to our lips, and we can repeat them while thinking of other things. After a time the new way of dealing with circumstances becomes a matter of habit, and is carried out without deliberation and without concern. If the repetition is continued, the subsidence of consciousness is carried still further. We jump without hesitation from the statement of the problem to its solution. The intermediate steps have become unconscious. We repeat the words of the play or the prayer with glib rapidity, but we find to our annoyance that the sense of the words eludes us. We try again and again to concentrate our attention on what we are saying; but the mind wanders incurably, and we find at the end of each sentence that we have paid no attention to its meaning. The conscious accompaniment of the act has been reduced almost to nothing.

Turning back now to the physical side of the affair—to the physiological substratum of the mental operations—we find that the physical element that diminishes with repetition is the rearrangement of the molecules of the ground-substance. When an entirely new relation is established in the mind—when we have an entirely novel thought—then there is the passage of a current through a previously untraversed portion of ground-substance—through a virgin soil. The passage of this current rearranges some of the molecules into polar parallelism, so that subsequent currents pass more easily. The next current finds a track already partly laid, and travels largely along the molecules that have taken up their permanent positions. A portion only of this current forces itself through the contiguous ground-substance, and enlarges the permanent track already begun. Each subsequent current travels along a larger channel—along a channel more nearly adjusted to its volume, and overflows less and less widely into the surrounding ground-substance. At length the channel attains dimensions proportioned to the volume of the current, and no further change in the ground-substance takes place. The strict concomitance between the amount of rearrangement of the molecules of the ground-substance and the amount of conscious mental activity, renders the inference unavoidable that *the rearrangement of molecules in the ground-substance of the gray matter is the physiological substratum of mental activity.*

An obvious corollary of the doctrine just laid down is that memory, which is inversely as the conscious effort of remembering, has for its physiological substratum the inverse condition, viz., the permeability of the channel formed. The more permeable the channel, the more readily the current passes, and the more readily the idea is repeated. Whenever we remember an idea, there is a current passing through the same district that was active when the idea first occurred to us. Every time that a current passes, it passes more readily, and every time that we recall an idea to mind, we recall it more easily. The physiological substratum of memory is the excavation in the ground-substance of channels connecting nervous regions. The more complete the channel, the more perfect the memory, and *vice versâ.*

Hence it appears that if a channel is completely excavated, so as to carry the entire current without leakage, there will be no conscious accompaniment at all; and it is found that when a mental process has taken place sufficiently often, we cease to remember it—we cease to have a conscious memory of it. Thus does conscious memory merge and fade into unconscious memory.

If the doctrine here advanced is correct—if a thought, a perception, a conception, has for its physiological substratum the passage of a current through the ground-substance and the rearrangement of the molecules in its path—then many phenomena become explicable that have hitherto been mysterious. It would be out of place to deal here at length with morbid processes; but an instance may be given to show what a powerful agent this doctrine is, and how greatly it helps to the solution of the problems as well of morbid as of normal phenomena.

Instances are not infrequent—two of them are published in the current number of *Mind*—of a severe blow on the head being followed by a permanent oblivion of all that occurred to the sufferer for an hour or a few hours previous to the blow. On regaining consciousness, he finds that the memory of his previous life carries him, not to the moment of the accident, but to a period several hours antecedent to it, and there stops. Upon our hypothesis a nerve-fibre may be represented diagrammatically by a hose-pipe filled with barley, all the barley-corns lying with their long axes parallel to one another and to the axis of the hose. The ground-substance of the gray matter, on the other hand, may be represented by a binful of barley, the corns lying at random. Whenever we have a thought, a perception, or a conception, there is the passage of a wave from one set of nerve-fibres through the ground-substance to another set, and as the wave passes through the bin, it shifts the barley-corns that lie in its path, so that instead of lying at random, they are turned with their axes parallel to the path of the wave. When this has just taken place, when the molecules, represented by the barley-corns, have only just been shifted, they are not stably and firmly arranged in their new positions. The very process of shifting them has, as it were, loosened their attachments, and it takes time before they settle down firmly in their new positions. It takes time, and a repetition of the nerve-wave. It is easy to see that a violent shake given to the molecules directly they have been shifted, and before they have settled down in their new positions, may derange their polarity, upset their parallelism, and restore them to their previous condition of random arrangement. In that case the paths traversed by the most recent impressions would be obliterated, and memory would cease at a certain period antecedent to the blow.

It is evident that in vast numbers of instances the molecules do not permanently retain their new positions. We do not remember the trivial events of every day, the materials of yesterday's dinner, and the contents of last week's *Times*. Whatever alteration was made in our cerebral structure by these events has been almost or altogether obliterated; and this obliteration of the newly-formed channels is as strictly physiological and as frequent an occurrence as the fixation of them into permanent ways. Whether the molecules shall remain in their new position, or whether they shall fall back into their previous state of chaos, is a matter which depends partly of course on their mobility, and partly on the intensity of the current—that is, of the impression. The mobility of the nervous molecules, the ease with which they are rearranged into new positions, and the tenacity with which they adhere to positions so acquired, are qualities which vary in each individual, and which determine for each individual the goodness or the badness, the strength or the weakness, of his memory. The intensity of the impression made, and therefore of the current that passes, determines the degree of shifting of the molecules, and therefore the tendency to remain in their new positions,—that is to say, the vividness of the memory of that particular impression.

However permeable a channel may become, it must, if it is to be kept permeable, be occasionally traversed by a current; otherwise the polarity of the molecules becomes disarranged, the permeability of the channel is diminished, the memory fades.

For a certain time we remember all occurrences, however trivial; but after a time memory of the trivial occurrences disappears, and traces remain of the more important impressions only. A little consideration will show that the memory of trivial occurrences is bounded by the last sleep. We can by an effort remember what we had for breakfast this morning, but by no effort can we recollect the material of our breakfast yesterday, unless there was some occurrence which made the impression unusually intense. And the same is true of the thousand trivial occurrences of the day. On the other hand, that melody with which we were so charmed yesterday morning, and which we strove in vain to recall in the afternoon, can now be remembered with scarcely an effort.

Hence it appears that during sleep there is a double 9
process going on in our brains. The activity that has been set going by impressions made in waking life is still continued. The molecules that were shifted into new positions are still oscillating from the shock. Those that were only slightly disturbed are returning to their original positions; those that were more profoundly moved are settling in their new places, presenting more stable attitudes to the action of surrounding forces. Regions that, perhaps after long repose, were disturbed in the day, still continue to emit a mild reverberation of their discharge, and the passage of currents at random through the highest regions under the sole influence of inequalities of pressure, and without guidance from external impressions, has its mental counterpart in the phenomena of dreams.