

so wide a field, I have doubtless overlooked much that should be included. Doubtless, too, various of the inquiries named will branch out into subordinate inquiries well worth pursuing. Even as it is, however, the programme is extensive enough to occupy numerous investigators who may with advantage take separate divisions.

Though, after occupying themselves with primitive arts and products, anthropologists have devoted their attention mainly to the physical characters of the human races; it must, I think, be admitted that the study of these yields in importance to the study of their psychical characters. The general conclusions to which the first set of inquiries may lead, cannot so much affect our views respecting the highest classes of phenomena as can the general conclusions to which the second set may lead. A true theory of the human mind vitally concerns us; and systematic comparisons of human minds, differing in their kinds and grades, will help us in forming a true theory. Knowledge of the reciprocal relations between the characters of men and the characters of the societies they form, must influence profoundly our ideas of political arrangements. When the interdependence of individual nature and social structure is understood, our conceptions of the changes now taking place, and hereafter to take place, will be rectified. A comprehension of mental development as a process of adaptation to social conditions, which are continually remoulding the mind, and are again remoulded by it, will conduce to a salutary consciousness of the remoter effects produced by institutions upon character; and will check the grave mischiefs which ignorant legislation now causes. Lastly, a right theory of mental evolution as exhibited by humanity at large, giving a key, as it does, to the evolution of the individual mind, must help to rationalise our perverse methods of education; and so to raise intellectual power and moral nature.

HERBERT SPENCER.

III.—PHYSIOLOGICAL PSYCHOLOGY IN GERMANY.

THE recent work of Professor Wundt* may be said to have defined the boundaries of a new department of research in Germany. It collects and puts into systematic form the results of a number of more or less isolated inquiries into such subjects as the functions of the several nervous centres, the precise relations of sensation in respect of quality and quantity

Grundzüge der physiologischen Psychologie, von WILHELM WUNDT, Leipzig, 1873-4.

to physical stimulation, the physiological distinction between sensation and idea, and the causes of the confusion between the two in many abnormal conditions of the organism. These and other inquiries have as their common aim the determination of the exact physiological conditions of a certain group of mental phenomena. Their common presupposition is that every mental process, from the simple sensation which follows as the direct result of external stimulation up to the most subtle and complex operation of thought, has, as its obverse, a physical process, that conscious activity goes on at every point hand in hand with nervous activity. Wundt has seized this general aim of previous researches, has sought to show the convergence of their methods as well as to fill up hypothetically many of the intervening spaces of the field.

The completion, even in rough outline, of this new scientific structure, may be regarded, we think, as an event of the first importance. Its real significance lies in the fact that it is the wresting of the whole field of phenomenal psychology out of the hands of the trained metaphysicians by an order of inquirers who bring no metaphysical assumptions to their new study, who are as free from the almost puerile negative dogmatism of the materialists as from the prepossessions of the transcendental psychologists, who clearly see the phenomenal distinctions between the spiritual and the material, and are content in the temper of true *Naturforscher* to confine their attention to the purely phenomenal aspects of their subject. In order to understand the full import of this movement, we may do well just to glance at the recent course of psychological speculation in Germany.

It is not too much to say that till the labours of the physiologists began, there existed nothing like a scientific conception of psychology in Germany. What went and still goes as psychology among professed philosophers is any kind of attempt to determine the substance of mind with the view of embodying this ideal in an ultimate ontological theory. We find little patience in the observation and classification of mental phenomena, little penetrative insight into the causal relations of these phenomena; on the other hand we see abundant metaphysical ingenuity in building new hypotheses on arbitrarily selected groups of facts.

These dominant features of German psychology might be illustrated by reference to the systems of all the professional writers on the subject from Leibnitz downwards. The method of philosophising common to these thinkers is the reduction of psychology to metaphysic; and the effects of this on the scientific character of psychology are seen most conspicuously in

the systems which accord a distinct place to a theory of mind. We refer not to such transcendental constructions as the *Lehre vom subjectiven Geiste* of Hegel, but to such quasi-scientific investigations of the subject as are offered in the system of *Pneumatik* left us by Leibnitz, in the scheme of *Eidologie* unfolded by Herbart, and even in the far more sober system of *Psychologie als Naturwissenschaft*, raised by Beneke. The obstinate persistence of the metaphysical method in this domain cannot better be illustrated than by a reference to this last attempt to found a science of psychology. Herbart had made a step towards a more scientific view of the subject by rejecting the venerable hypothesis of occult mental faculties. It was no inconsiderable reform in psychology to substitute the conception of a mental process for that of a mental faculty; but Herbart, unfortunately, missed the rich fruit of this new idea by postulating a number of conceptual processes—such as mutual resistances and endeavours to blend—of which we have no certain knowledge. Beneke, while professing to follow Herbart's direction,* really re-instated in a modified form the anti-scientific conception of mental faculties. He looked on every mental event or "structure" as the result of two factors, a stimulus (*Reiz*) and an original faculty or force (*Ur-vermögen*). It is true that he gave a special interpretation to these terms, and cordially rejected the old "powers," such as memory, imagination, and will, which he termed "hypostasised class-notions." It is also true that he recognised the possibility of the growth of new mental capabilities. Nevertheless, this theory of *Ur-vermögen*, as real forces constituting the elements of the mind, is distinctly unscientific and metaphysical. In order to transform it into a scientific conception, it would have been necessary to regard mental phenomena as the obverse of material processes; and for this the metaphysicians were unprepared.

The foundations of an inductive and experimental science of mind in Germany had to be laid by another class of workers than the metaphysicians. The materials of the science were ready to hand. The prevailing tendency of the Germans to subjective reflection renders them familiar with the chief operations of thought, emotion, and action. Every cultivated German could think with a certain amount of concentration on such topics as the perception of the external world and the freedom of the will. What was wanted for laying the founda-

* In point of fact he thought he was making a great advance on Herbart, for while the latter had recognised three bases of psychology, metaphysics, mathematics, and internal experience, Beneke admitted only the last.

tions of the new science was familiarity with strict scientific methods of research, a habit of mind,—the result of severe discipline in other departments of inquiry,—of distinguishing fact from theory, of seeking the most precise definition of the phenomena to be studied, and of demanding the most rigorous proof of any proposition offered in explanation of the facts. These qualifications were possessed in an eminent degree by that line of distinguished physiologists of which Johannes Müller may perhaps be termed the first ancestor.

That physiologists have thus gradually encroached on the region of psychology, is a fact which should excite no wonder. For in a certain sense physiology may be said to include the whole of empirical psychology. If every mental act is a function of some part of the nervous system, then a complete account of this system would imply a complete explanation of mental processes, which are its functions.

Of course, physiological science is even now far from that point at which she could supply from the objective side a full interpretation of all known mental phenomena. The exceedingly subtle actions of volition, for example, still await their physiological explanation—an explanation which, when it arrives, will serve to dispel from the subject a good deal of metaphysical haze. The region in which German physiology has been most successful in elucidating mental processes, is that of the senses. Here it has been possible to employ the objective method with full advantage. The quality and quantity of the physical process to be studied have been accurately defined by means of carefully arranged experiments, and the variations in the subjective sensation accompanying changes in the objective process, have been estimated in the best possible manner. In this way the analysis of sensation has been carried to a much further point than that reached by subjective observation alone. Moreover, both the quality and the quantity of our sensations have been more precisely determined, and new light has been shed even on such *primâ facie* un-physiological subjects as the nature of perception and the genesis of our notions of space. Not only so, but the careful experimental study of the operations of sense has involved a consideration of some of the more intricate mental laws. It has been found that what seem to be the most simple impressions of an adult mind contain an admixture of intellectual and volitional activity; and thus it has happened that *savants* who proposed simply to make an exhaustive study of the senses and their functions, found themselves compelled to discuss the nature and laws of the higher mental operations.

The principal steps in the history of this new branch of

research in Germany may be easily indicated.* It received a part of its impetus at first from a metaphysical impulse. Johannes Müller, the founder of this school of workers, thought he could supply a physiological basis for Kant's doctrine of the spontaneity of the subject in perception. His foremost proposition was that the several orders of nervous fibre have their own specific energy, owing to which they do not respond in the same way to a given stimulus, as electrical or mechanical action, but, reacting according to their peculiar nature, produce out of precisely the same mode of stimulation, qualitatively unlike sensations. This theory has been very warmly discussed by later writers, and has proved a powerful stimulus to an exact observation of the nature and action of the senses. Müller sought, moreover, to find a physiological equivalent for Kant's notion of space as a subjective form, and he did so by assuming that the retina has an innate feeling of its own extension. This hypothesis, which seems to imply one of two rather startling assertions, either that the retina is the seat of sensation, or that the mind wherever situated has a direct cognisance of the retina and its arrangement of parts, was the first crude form of the "nativistic" theory of visual perception. It has several times been elaborated into new forms, some of which are sufficiently unlike their prototype. Among the latest exponents of this view, E. Hering may be singled out as distinguished by the thoroughness of his knowledge and the force of his reasonings. To this nativistic theory of visual perception there has been opposed the "empiristic" view, according to which our intuitions of direction and distance have been slowly built up out of more elementary experiences. This theory, while taking Berkeley's doctrine as its starting point, has been worked out with characteristic German independence into new forms. We may name Lotze, Helmholtz and Wundt among those who have done most to reconstruct the derivative hypothesis. The discussion has given a great impetus to experimental research; and whoever has carefully read the literature of the subject, for example, Helmholtz's great work on *Physiological Optics*, will probably admit that these methods of research only need to be worked to a further point in order to yield ample data for the solution of the question.

We may add that in the present paper Wundt's contribution to the theory of space-perception will not be dwelt on, it being intended, with the permission of the editor, to discuss the

* For a fuller account of these researches, see the writer's *Essay on Recent German Experiments with Sensation*, in his volume, *Sensation and Intuition*.

several German theories on this subject, together with the facts on which they are based, in another article.

While the physiological contribution to mental science in Germany thus originated in part in a desire to support certain metaphysical principles, it soon became independent of any such extraneous motive, and was sustained solely by the scientific impulse to ascertain and to interpret as completely as possible the facts brought under investigation. The fruit of this eminently positive treatment of the phenomena of the senses lies stored in the highly valuable collection of discoveries respecting the quantitative aspects of sensation and the relation of these to the accompanying nervous processes. This department of physiological inquiry has been largely carried on by help of electric stimulation, a mode of experiment introduced by Ritter, improved on by Purkinje and others, greatly elucidated by the celebrated researches of Du Bois Reymond and his followers into the electric phenomena of nerve, and giving promise recently of throwing light not only on the actions of the senses but also on those of the central organs. It is impossible to review in detail the long series of investigations relating to the dimensions of sensation which have been carried out by German physiologists. They date back to a period antecedent to that of Müller, though they have only recently been carried out in a systematic way by a kind of scientific concert. The results thus attained are very abundant and must be considered as a valuable addition to the physiological basis of psychology. They include among other points approximate determinations of the degree or force, and also the duration of stimulation necessary to the least possible sensation, of the changes in a sensation consequent on the prolongation of a given stimulus, and of the precise duration of a sensation after the stimulation has ceased. This quantitative determination of sensation was naturally carried out in the first instance in the department of visual impression. Ehrenberg, Johannes Müller himself, and Plateau may be mentioned among those who first assisted in building up this part of the science of the senses. It is however by the labours of more recent investigators, including Volkmann, E. H. Weber, Fechner, Wundt, and Helmholtz, that the quantitative appreciation of sensation has been mainly accomplished. Weber's researches into the limits of discriminative local sensibility, directed in the first instance to the impressions of the tactile surface, and extended by himself and others, including Helmholtz, Förster, Aubert, to retinal impressions, mark an important step in the progress of this method of study, while the yet more remarkable generalisation on the facts thus collected reached by

Fechner and formulated by him in his famous psycho-physical law, has served to reduce this department of observation to something like a distinct and complete branch of the science of physiological psychology. Fechner's employment of the least recognisable sensation and of the least recognisable difference of sensation as constant units, the same for all orders of impression, must be regarded as a most fruitful extension of the scope of subjective observation by the addition of an objective method acquired in the region of physical research.

One or two other lines of inquiry pursued by these first builders of the edifice of physiological psychology deserve particular mention. It may be readily supposed that in a study of sensation carried on *pari passu* with the observation of nervous action, the question of the ultimate elements of our sensuous impressions would receive further elucidation. By help of the objective method here employed, we are enabled to look back on simple types of feeling which precede and enter as constituents into the seemingly indivisible sensations which subjective observation reaches as its ultimate elements. This extended analysis of sensation has led to the inquiry how far all the strongly marked orders of impression, the feelings of sound, light, &c., contain some common elementary basis, and thus the question of the specific energy of the different orders of nerve has acquired a new significance. Finally, attention may be called to the fruitful employment of objective experiment by these physiologists with a view to determine the proportion of immediate impression and of derivative inference in the simple perceptions of the senses. This line of inquiry, which is of supreme value for determining the precise operation of the laws of intellectual action, has been mainly directed to the subject of space-perceptions, that is to say, to the modes of visual apprehension of direction, distance, magnitude, &c. At the same time the experimental study of the illusions of the senses has helped to elucidate the growth of objective perception as a whole, showing under what conditions subjective feeling passes into objective intuition, and what are the elements which co-operate in the formation of our clear and stable conceptions of single and persistent objects.

With such genuine work already done, and such positive results already established, Wundt has set himself to the important supplementary task of bringing together the several lines of inquiry into one scheme and co-ordinating them as parts of one science. It is worth noting that he names this new branch physiological psychology, and not mental physiology, an expression adopted by some English writers for a

similar field of research. Wundt's phrase seems to lay stress on the fact that a certain portion of the science of mind is to be built up by an extension of the proper methods of physiological inquiry. It marks off that region of mental facts and laws which requires for its complete illumination the co-operation of physiological observation and experiment.

It will be quite impossible to give in a single article a very full account of the varied and closely packed contents of Professor Wundt's treatise. We must be content to indicate very briefly the main divisions of the author's exposition, and after this to enter more fully into one or two of the most valuable among his original contributions to the science he seeks to define.

The first section of the work is devoted to the nervous system and its functions. The latest results of anatomical research respecting the nature of the nervous elements, the paths of the conducting fibres in the central regions, and the distribution of the masses of grey matter, are ably stated, and light is thrown on the precise relations of the several parts of the nervous centres by a very full account of their morphological development. The author is no less full in his account of the functions of the central masses, making good use of the latest experiments, yet always maintaining a wise caution in drawing conclusions. As an example of this scientific moderation we may quote the remark, greatly emphasised, that the precise localisation of the central functions is rendered exceedingly difficult by the existence in the nervous substance of so large a capability of vicarious or substitutive work, which circumstance makes the conclusions of vivisectional experiment as well as of pathological observation almost nugatory.

Passing by a chapter on the physiological mechanics of the nervous system which contains a series of more or less hypothetical reasonings of great ingenuity, and worthy to be compared with Mr. Spencer's speculations in the same domain, we come to the second section of Professor Wundt's work, that which treats of the sensations. This part of the treatise is full of interest from beginning to end. To sensation are assigned three properties, intensity, quality and emotional tone (*Gefühlston*). The duration and extensive magnitude of a sensation are not looked on as elementary and original properties. A chapter on the intensity of sensation gives us a clear summary of the experiments of Weber and Fechner, and a statement of the psycho-physical law laid down by the latter. Wundt makes a valuable addition to Fechner's method in supplementing the conception of a "threshold" (the point at

which stimulation results in a noticeable feeling) by that of a maximum "height," namely, the point at which increase of external stimulus ceases to be followed by noticeable increase of sensation. With each of these values Wundt connects a distinct mental quality. Sensibility to stimulation is estimated by the numerical value of the threshold, varying inversely with its magnitude. Receptivity for stimuli, on the other hand, corresponds to the position of the maximum height, varying directly with the numerical value of the same. Thus a person in whose case the threshold of a given order of sensibility was very low and the height correspondingly great would be said to possess both great sensibility and a high degree of receptivity for impressions. Wundt, rightly as we think, finds the full psychological significance of Fechner's law in the fact that in comparing feelings, whether as to quantity or as to quality, we have in general not an absolute but only a relative measure. The magnitude of any sensation is necessarily appreciated in relation to the antecedent feeling from which it is a transition.

A chapter on the quality of sensations states in a very clear and succinct manner the latest knowledge representing the anatomical and physiological conditions of the several orders of sensation. Wundt here controverts very fully Müller's doctrine of specific energy, contending that the qualitative differences of the visual, auditory, olfactory, and gustatory sensations depend not on any fundamental peculiarities of the respective groups of nervous fibres, but exclusively on the peculiar terminal apparatus attached to these, that is to say the peripheral expansions of the fibres into the rods and cones of the retina, the organ of Corti in the cochlea, and so on. This question of specific energy, to which Wundt devotes considerable space, will receive a fuller investigation further on in the article. The author seeks to determine precisely the mutual relations of the senses, with reference both to the nature of their stimuli and to the characteristic qualities of the feelings themselves. Thus it is well shown that sight, though it is to be ranked with hearing in the fineness and stability of its discrimination and classification of sensation, resembles the senses of smell and taste in so far as it lacks that power of responding differently to the slightest difference of the external stimulus which belongs to the sense of hearing; and this affinity is supposed to be connected with the fact that in hearing as in touch the mechanical movement of the stimulus is transported *immediately* to the terminal structure of the nervous fibre, whereas in sight, as also in the chemical senses, the movement of the stimulus in its transference to the nervous extremity is transformed into some other form of movement. Wundt considers it

to be a legitimate supposition that in sight, as well as in smell and taste, the mechanical process passes into a chemical one. The phenomena of the two higher senses are discussed with great fulness, and the views of others, more especially those of Helmholtz, are subjected to a painstaking criticism.

Wundt completes his account of the sensations by devoting a chapter to the nature and conditions of the "sensuous feelings" (*sinnliche Gefühle*), that is to say the several emotional shades of sensation, including pleasure and pain, together with certain effects more or less analogous to these as the feelings of the restful, the exciting, and of the cheerful and the gloomy. These subtle shades of feeling which accompany the sensations of the ear and the eye and enter so prominently into æsthetic impressions are defined with considerable ingenuity, even though one has to admit that the writer is here treading on a somewhat slippery ground, for which the strict methods of physiological science are scarcely fitted. With respect to our feelings of pleasure and pain, an ingenious though rather forced attempt is made to demonstrate a uniform relation of emotional quality to intensity of sensation in the case of every sense. Wundt conceives that with increase of stimulation there is a gradual rise through degrees of the pleasurable to a point of indifference, beyond which there is a rising scale of the painful. The case of sensations which appear to be painful even in their feeblest degrees, for example, certain well-known sensations of smell and taste, is disposed of by the supposition that in these instances the point of indifference is scarcely higher than the threshold of sensation, so that the scale of the pleasurable is contracted within such narrow limits as to be unrecognisable. That is to say, Wundt conceives that the points of maximum pleasure, indifference, &c., have very different heights in different classes of sensation.

The next section on "*Vorstellungen*" (i.e., Presentations and Representations) brings us into a region of physical phenomena where it is much less easy to apply the exact and certain methods of physiological science. Still the author succeeds in throwing a good deal of new light on this subject by making use of the most recent objective experiments. The whole question of the nature and origin of our ideas of space, which occupies a considerable part of this section, we hope, as we have said, to deal with in another article. Suffice it for the present to say, that Wundt distinctly connects himself with the "empiristic" party, giving great prominence to the feelings of innervation (which is but another name for Professor Bain's feelings of expended energy), as a main factor in the synthesis by which our space-intuitions are built up. The author enters

too very fully into the relations of our musical system, and discusses in a very suggestive way the subjects of tone-relationship, key, musical rhythm, &c.

A chapter of this section which deals with the representations of the imagination shows a wide acquaintance with the facts of hallucinations, and in the psychological use which it makes of the phenomena of mental pathology may be compared with M. Taine's treatment of this subject in his interesting treatise *On Intelligence*. The physiological basis of hallucination is reasonably supposed to be a more energetic central impulse than that of normal fancy and of memory, which impulse reaches the peripheral regions of the senses, and so approximates to the nervous process of perception. Wundt has also some valuable suggestions for explaining many of the seemingly arbitrary associations which present themselves in dreams. In another chapter on complex representations, he attempts to trace the psychological genesis of abstract ideas, and to assign their physiological correlatives, and is naturally led to criticise Kant's doctrine of subjective forms, both of intuition and of the understanding.

The following section headed "Consciousness and the reciprocal action of Presentations" constitutes perhaps the most stimulating reading in the two volumes. The whole subject of the nature and limits of distinct consciousness, including its physiological conditions, is worked out with much originality, though the author here as in some other places betrays a rather dangerous tendency to wander into the unscientific bypaths of metaphysical speculation. The precise nature and the physiological mechanism of voluntary Attention receive a great deal of new light from a group of experiments of the highest interest, of which it may not be too much to say, that they will be new discoveries to nearly every psychological student in this country. Into this part of Professor Wundt's work we shall have to look rather closely presently. The discussion of attention in its operation on intellectual states is followed by a chapter on emotional operations (*Gemüths-bewegungen*) which will be curious to English readers as following in the wake of the other German psychologists in their treatment of this subject. Thus, for example, the old distinction between the feelings and the passions (*Affecte*) is retained, and the impulses of desire and aversion are treated as forms of emotional agitation. The most original feature in this chapter is an attempt to deduce some of the characteristic effects of passion from the overpowering action of emotional excitement on attention. To this point we shall return when expounding the author's theory of attention.

The last section of the work is devoted to an exposition of the several orders of bodily movement, including those of emotional expression. Here the subject of volition and freedom naturally comes in for discussion. The author finds it easy to refute the notion that motives, regarded as invariable quantities, are the whole cause of action, and lays great stress on the natural basis of individual temperament and *character* as an important factor in volition. He finds the true relation of voluntary to reflex movements to be not that the latter fall under the category of causality which the former dispense with, but that while the latter have only an external and physiological determination, the former have both a physiological and a psychological. But is this last an essential step in the process? Here Wundt distinctly meets the supposition of automatism which, oddly enough, is just now talked about in this country as though it were a quite new hypothesis.

In treating the subject of emotional expression, Wundt finds occasion to offer some valuable criticisms on the theory of Darwin. Wundt himself reduces the laws of expression to three principles, namely, those of the direct change of innervation, which answers to Darwin's third principle, and is defined as including the immediate reflex effect (*Rückwirkung*) of the strong emotion on the central parts of motor innervation, the association of analogous sensations, and the relation of movement to the conception of the senses, as illustrated in all mimic gestures, &c. We agree with Wundt in rejecting Darwin's principle of contrast, but we fail to find in this new attempt to define the principles of emotional expression an exhaustive treatment of the subject.

In this rapid survey of the contents of Professor Wundt's two volumes, we have been able, we trust, to show how full and varied is the interest which it offers to the psychological student. Even where the writer fails to exhaust a topic and to supply an adequate explanation of a problem, he renders a valuable service by presenting the subject under some fresh and striking phase, and, in not a few instances, by raising a new problem for future investigators. When to this we add that many of the discussions are supplemented by clear and often ingenious criticisms on preceding theories, more especially the doctrines of the two great leaders of psychology in Germany, Kant and Herbart, the reader will understand how valuable a treatise is here presented to the student of mind. We will now seek to illustrate still further the importance of Wundt's work and of that department of German research with which it is connected, by entering more fully

into two of the most original passages of the book. The first of these is the author's peculiar treatment of the principle of the specific energy of the nervous structures; the second is his fresh and striking account of the processes of attention on their mental and physical side.

The theory of the specific energy of the nerves was, as we have remarked, first built up by J. Müller, who thought by means of this idea to supply a physiological basis for Kant's doctrine respecting the subjective conditions of knowledge. The facts on which it reposed were the following. First of all the several orders of sense-nerve have stimuli peculiar to themselves which do not act on the other orders. Thus the optic nerve has ether-vibrations as its proper stimulus. Secondly, every nerve of sensation reacts on the stimuli common to the several orders of nerves (mechanical and electric agencies) only in the form peculiar to itself ("specific" form). But, in fact, as Wundt points out, the first of these propositions does not hold for the most extended class of nerves, those of the skin, since these lack a special stimulus, and are only acted on by a common mode of stimulation (mechanical action).

With further knowledge respecting the nervous structures, Müller's doctrine of specific energy had to be modified. The form which this theory now commonly took was that the qualitative differences among our sensations depend not so much (if at all) on specific differences in the conducting fibres as on specific peculiarities in the central terminations, namely the cerebral ganglionic cells. The nervous fibres were now spoken of as like electric wires which produced the most various results according to the different apparatus attached to them.

Against this form of the theory Wundt directs his argument, contending that the various elements of the centres no less than the connecting fibres are "functionally indifferent," being able, *per se*, to react just as well in one way as in another, and that the qualitative differences in our sensations depend exclusively on the peculiar forms of the processes set up in the fibres. These forms are mainly the result of the peculiar terminal organs attached to the peripheral extremities of the fibres, such as the rods and cones of the retina, the organ of Corti in the cochlea, &c. No greater differences of structure are discoverable in the central elements than in the peripheral nerves. The connecting fibres are indistinguishable in structure, and as to the ganglionic cells their differences refer simply to magnitude, form, and the mode of origin of their processes. The phenomena of vicarious action, by which one part of the central tissues does duty when another part is incapacitated, and which so frequently occur in pathological

observation and in physiological experiment, seem to indicate the fundamental similarity of the central structures as to functional capacity.

Wundt holds, then, that no nervous element, whether fibre or cell, has for its specific function the production of one order of feeling, but that a given variety of feeling is correlated with a definite variety of neural process, which process might as well take place in one fibre (or cell) as in another. The reason why one species of feeling is commonly produced by one set of fibres and cells, is that the form of process appropriate to this feeling is customarily carried out along these particular lines, and this is owing to the peculiarity of the various peripheral endings. Thus the reason why the excitation of a certain group of sensory cells is accompanied with a sensation of sound while that of another group is accompanied by a sensation of light, is to be looked for not in any specific differences of these cells or their connected fibres, but solely in the difference of form in the two series of molecular movements transmitted to the two groups.

The greatest difficulties in the way of the hypothesis of specific energy are to be found, says Wundt, in dealing with the qualitative differences of feeling among the sensations of the same sense. He enters very fully into the question whether the several sub-varieties of the sensations of colour and of tone are dependent on specifically different sets of nervous fibres in the two organs concerned, or whether they are connected with different forms of molecular movement in the same fibres. It is known that Helmholtz, reviving a hypothesis of Thomas Young, supposes that in the retina there are three sets of optic fibres corresponding to three classes of elementary sensations, —namely, those of red, green, and violet, or blue. Again he formerly conceived that the fibres of Corti, which constitute one of the terminal structures of the auditory nerve, are a kind of key-board, each filament being set in motion only by series of vibrations which have an approximately equal rapidity, and so subserving exclusively sensations of tone of nearly the same pitch; and he still supposes that the fine gradations of pitch which the ear is able to distinguish depend on a simultaneous excitation of contiguous fibres in different degrees. Wundt rejects both of these hypotheses. With respect to the eye, he urges that anatomy offers no solid basis for three unlike classes of optic fibre. He also lays stress on the fact that the eye is unable to analyse sensations of colour into their supposed elements. But his main objection is based on the fact that the smallest visible point of light is never perceived as a particular colour. Hence, he argues,

even in seeing the *minimum visibile* the three hypothetical sets of fibres must co-operate. But this seems to be irreconcilable with the known diameter of the rods, each of which is supposed to be continuous with a primitive fibril. The difficulties with respect to the ear are, Wundt thinks, still greater. He maintains, in opposition to Helmholtz, that a simultaneous excitation of two adjacent fibres would result not in a single intermediate tone, but in the two tones answering to the fibres, and that therefore, since our sensations of tone constitute a *continuum*, the hypothesis of definite pitch-fibres would require an infinite number of nervous threads.* Wundt contends further that to postulate differences of fibre for qualitative differences among the sensations of the remaining senses, as taste and smell, is distinctly opposed to the teachings of anatomical science. We would direct the reader to Wundt's elaborate arguments on the whole subject, which are too long to be given here in detail. It is obvious that if Wundt's interpretation of the facts in this instance is correct,—and we confess that the cumulative effect of his arguments is very considerable,—we have proof positive that within certain limits at least a variety of stimuli acting on the same nervous elements produces qualitatively distinct sensations. And this is a powerful argument for Wundt's whole theory of the nervous conditions of quality of feeling.

But how, it will be asked, is Wundt's doctrine that quality of feeling depends solely on form of stimulation to be reconciled with the fact that definite groups of fibre, *e. g.* those of the retina, respond only in one way, whatever be the stimulus acting on them, and with the further fact that after the peripheral terminations of the fibres are removed, as in the case of the loss of the two eyes, the stimulation of the truncated nerve is always followed by the mode of sensation peculiar to it in its normal condition? Wundt seeks to get out of this difficulty by postulating an "extraordinary capacity for self-adaptation to stimuli" (p. 351) in the nervous substance. The optic fibre, after having been acted on in innumerable instances by the stimulus of light, has its molecular arrangements so adapted to this particular variety of stimulation that it cannot be acted on by any form of stimulus, at any point in its course, except in this one mode. Wundt thinks this view of the matter is supported by the fact that the function of an organ of sense must be sustained through its appropriate

* It is rather odd that Wundt does not call attention to the fact that Helmholtz's supposition of certain fine differences in sensation of tone depending on varying proportions of activity in the same two fibres is *pro tanto* an admission of Wundt's point.

external stimulus for a certain period, if the form of feeling peculiar to the organ is to survive the loss of the organ. Thus it is a familiar observation that those born blind and deaf lack absolutely the sensations of light and sound, whereas those who have become blind and deaf retain their sensations in the form of dreams, recollections, etc., for many years.

It would thus appear that Wundt's theory is not in reality so very different from the older doctrine which it seeks to supplant. He admits in effect that in the present stage of organic development the nervous fibres have something indistinguishable from a specific function, since they can only respond to stimuli in one particular way. Not only so. Difference of function will be followed, sooner or later, by difference of structure, and it appears to follow from Wundt's theory that the optic fibres and their connected cells, for example, must have become structurally unlike the other classes of sensory fibres and cells, though anatomical observation has not as yet succeeded in detecting any characteristic differences.

Wundt claims for his theory of nervous action the advantage of being the "more conceivable psychologically."

"We can," he says, "easily represent to ourselves that our consciousness is qualitatively determined through the nature of the processes taking place in the organs which sustain it; but it is difficult for us to conceive how this qualitative existence is to become changeable merely with the *local* differences of those processes."—(pp. 353, 4.)

This consideration seems to us to be a little forced, since the supporters of the doctrine of specific energy have referred the peculiarities of function not to mere local arrangement, but to undiscovered peculiarities of structure in the nervous elements themselves, whether fibres or cells. On the other hand, it may well be contended that, in distinguishing two perfectly similar impressions, *e.g.* two points of light, the only physiological basis for such distinction is the local separation (though not the local *arrangement*) of the elements concerned. All that is required for "psychological conceivability" is that to difference of feeling some difference of neural process should correspond; and this requirement is equally satisfied, whether two like processes take place in different elements, or two unlike processes in one and the same element.

In concluding this account of Wundt's theory of nervous action, we would remark that its principal significance lies in its bearing on the hypothesis of evolution. It distinctly points to a gradual differentiation of nervous tissues having unlike functions. Wundt's merit lies in the fact that he has sought with

considerable success to transform the old theory of specific energy, so as to harmonise it with the latest biological conceptions.

The subject of specific energy, on which we have just dwelt, is mainly a physiological one; we will now pass to Wundt's treatment of a more properly psychological subject,—namely, the nature and laws of Attention.

Wundt begins his discussion of attention by a provisional definition of consciousness, with which we need not here concern ourselves. He distinctly rejects the idea of "unconscious mental states" awaiting the process of reproduction. On the other hand, he draws a sharp line between clear and obscure consciousness, recognising varying degrees of each both in one and the same mind, and also in the scale of animal intelligence. The circle of distinct consciousness is determined by the process called attention. Wundt draws an analogy between this region of attention and the field of distinct perception in vision, and makes use of the terms "field of view" and "point of view" to illustrate the distinction between all the presentations at a given moment and that part of them to which attention is directed.

The entrance of a presentation into the internal field of view is termed a Perception; its entrance into the point of view, an Apperception. The analogy between the inner and the outer point of view lies in the fact that each moves successively over the different parts of the field of view. On the other hand, the inner point differs from the outer in the property of alternately expanding and contracting (its degree of illumination varying inversely), so that, strictly speaking, it is not a point, but a narrowly circumscribed though variable surface. The narrower and brighter this inner "point," the greater the obscurity of the remaining field. This is well illustrated with respect to objective attention, in the effects of a momentary visual impression by electric illumination, which show further, what might be expected, that the extent of this point of distinct consciousness increases with increased duration or with frequent repetition of the impression.

The influences which lead attention in this or that direction are either external or internal. By the former Wundt understands strength of impression, &c. One condition of recognising a particular element in a complex impression is that this element should have been experienced apart shortly before. In this way we can "pick out" in a composite mass of tones notes which we have just heard separately. By internal conditions Wundt means the influence of memory and anticipation in recognising impressions. Thus in examining a fresh mineral

specimen, which, as we conjecture, is of a particular variety, we form a distinct image of some remembered specimen, and by help of this recognise the specimen now before us. Subjective observation shows that wherever attention comes into play, this kind of activity is involved.

Attention is known to be accompanied with a feeling of tension either in the organ of sense engaged, or, as in the case of voluntarily controlled reminiscence, in the head. In both cases the feeling results from the innervation of the voluntary muscles, which is accompanied by an actual tension of the muscles, and in consequence of this, through altered pressures on the skin, by peculiar feelings of touch. Further, when external impressions are anticipated, the feeling of strain in attention is found to depend on the strength of the impressions.

These phenomena show that attention accommodates itself to the particular impression of the moment. The agitating effect of surprise is due to the fact that attention has not accommodated itself at the moment in which the impression is received. This accommodation is of a two-fold kind, having reference both to the quality and to the intensity of the stimuli.

And what, it may be asked, is the mechanism of this process of apperception? When attention is awakened, we must, says Wundt, imagine the following order of events:—

“The first impulse follows in every case either through an external (physiological) or through an internal (psychical) stimulation. Such a stimulation has as its immediate consequence a presentation, whether an image of intuition or one of imagination; and this in the first instance lies outside the internal ‘point of view.’ Every sensory stimulation, moreover, is at the same time transmitted into the central regions of voluntary innervation, from which, as we conceive, it is capable of being conveyed further in one of two ways, either first of all back again to the sensory domain, whereby the conception is strengthened, or secondly to the domain of the voluntary muscles, whereby those muscular tensions arise which help to form the feeling of attention, and which on their side react on attention, strengthening it, according to the law that associated feelings support one another. In the predominant reaction on the sensory tracts, from which the process originally set out, consists essentially the difference between attention and voluntary movement. In the case of the latter the central stimulation is mainly directed to the muscles, which during the processes of attention are only drawn into a subordinate co-movement. Yet both processes are of course connected in many different ways, since the voluntary movements throughout shape themselves according to the presentation which occupies the point of view of consciousness.”—(p. 723.)

Wundt appeals in confirmation of this theory respecting the reaction of the tracts of motor innervation on the sensory domain to the common fact that by sheer force of will, we can call up feelings scarcely distinguishable from vivid impressions.* His main argument for this theory, however, is derived from a curious series of experiments, to the consideration of which we will now turn.

These experiments aim at determining the duration of the processes involved in recognising a momentary external impression, and in recording this recognition by a simple voluntary movement, and they aim further at discovering what variations in this duration are brought about by variations in the impression and its attendant circumstances. They are of an extremely curious and interesting character, and have proved in the hands of Wundt fruitful of psychological interpretation.

The several steps of the process here studied are thus marked off by Wundt: (1) the transition from the organ of sense to the brain; (2) the entrance into the field of view of consciousness or perception; (3) the entrance into the point of view of attention or apperception; (4) the action of the will in giving the necessary impetus to the motor nerves; and (5) the transmission of this motor excitation to the muscles. The first and last of these stages are purely physiological. As to the remaining three processes, that of perception may reasonably be supposed to be simultaneous with the excitation of the sensory regions, so that its duration is included in that of the process of sensory conduction. If we speak of a perceptual period, we can only mean the time required for the movements transmitted to the sensory centres to produce the necessary excitation there. Similarly, the volitional period (No. 4) must be looked upon as psycho-physical, it being highly improbable that the action of the will is a separate action occupying a distinct time. There remains the apperceptual period, which is also psycho-physical, since we can speak of it either as the time required for the transformation of a perception into an apperception, or as the interval needed for the transition of movement from the sensorium to the cortical portion of the cerebrum. The whole period thus divided, Wundt, following the usage of astronomers, terms the physiological time. Since in many cases we cannot

* The writer of this article may be allowed, perhaps, to remark that without any knowledge of Wundt's speculations on this subject, he himself suggested that the phenomena of voluntarily awakened subjective sensations distinctly point to a reaction of the voluntary process on the sensory tracts. See *Sensation and Intuition*, pp. 63, 64.

separate the apperceptional and the volitional periods, we may speak of them as one under the term reactional period. In this way we shall have four steps in the process, two purely physiological, the first and the last, and two psychological or psycho-physical, those of perception and reaction. There is every reason to believe that the two latter occupy a much longer time than the two former. Hence when the whole physiological time undergoes considerable alterations, we must refer it to changes in the duration of these central processes. The experiments by which the varying values of the physiological time have been determined were originated by Bessel in his investigations into the personal equation in astronomical observation. They have since been further developed by several *savants* in the interests of physiological science, including Hirsch, Donders, De Jaager, and in a special manner by Exner. The ingeniously constructed apparatus (chronoscopes) by which these observations have been made are fully described by Wundt in an appendix. Here it is sufficient to say that by help of electric currents they give a wonderfully precise record both of the fraction of a second, at which the impression of light or sound takes place, and of the interval between this and the completion of the act of manual registration by which the impression is recorded.

The experiments to be considered fall into three series: (1) those which investigate the physiological time under the simplest conditions, that is, when the observer (who records his impression) is expecting an impression of a certain quality and strength, but is uncertain as to the precise moment of its arrival; (2) those in which a change of the physiological time is effected by the addition of the favourable circumstance that the exact time of the impression is known beforehand; and (3) those in which the physiological time is modified by the introduction of some unfavourable circumstance, as for example, that the nature of the impression is unknown, or that the kind of movement to be carried out in the act of registration is made to depend on the character of the impression, and cannot therefore be prepared for in the same manner.

We cannot attempt to give more than some of the most interesting results of these experiments. Thus, for example, Wundt found that under the conditions imposed in the first kind of experiment, the duration of the perceptional and apperceptional processes is a constant quantity for all orders of sensation *at the threshold of stimulation*, the whole time occupied here being of course considerably longer than that required in the case of more powerful stimulation. Further, he found that when considerable changes are made in the force

of the stimulus the physiological time decreases with the increase of this force, but that when very slight changes were introduced, this rule did not hold. The author concludes therefore, that within these narrow limits the effect of increase of stimulation in shortening the whole process is evanescent as compared with the effect of the varying influences of the condition of attention at the moment. He argues too, that the increase of rapidity with increase of stimulus, must be referred mainly, though not exclusively, to the psycho-physical stages of the process.

In the second series of observations in which the time of the impression is pre-announced by a signal, Wundt found that with repetition of the experiments under precisely the same conditions the physiological time decreases till it reaches an infinitesimal quantity, or vanishes altogether. That is to say, the act of registration perfectly synchronises with the application of the sensational stimulus. Wundt accounts for these rather startling results by the supposition of a "preparatory strain (*Spannung*) of attention." Where the physiological time becomes very small we may infer that the observer's attention has so well accommodated itself that the apperceptual period vanishes and apperception and volitional excitation become co-instantaneous with perception. Where the physiological time reaches zero, Wundt imagines that the observer is involuntarily seeking to make the act of registration exactly synchronise with the arrival of the impression, and in doing so is necessarily guided by a feeling for the perfect contemporaneousness of the impression to be observed and the feelings of innervation and touch which accompany and announce, so to speak, the act of registration.

Suddenness of impression increases the physiological time very considerably, probably through the retardation of the reactional processes which cannot now be prepared. In the case of a faint, sudden, and wholly unexpected sound, the physiological time reached the great magnitude of half a second. If instead of rendering the impression unforeseeable, the procedure is complicated by leaving the act of registration unknown beforehand, the physiological time is similarly lengthened. This fact points distinctly to the existence of a *volitional* period. The length of this period moreover is found to depend on "the physiological connections in which the central sensory regions stand to the reacting motor apparatus." These connections will obviously be determined in part by the external order of impressions, as is illustrated in an experiment of Donders, which shows that visual signs are less closely associated with vocal action than are auditory signs.

We can only just glance at some of the more complicated experiments here enumerated by the author. It is found that when the impression to be recorded is accompanied by an interfering or distracting side-impression, whether continuous or momentary, the physiological period is lengthened. The disturbance of such a side-impression moreover is greater when this is heterogeneous to, than when it is homogeneous with, the main impression. Thus a sound distracts the mind from the observation of a light-impression with a greater force than another visual impression would do. The physiological reason of this difference is too obvious to require naming. In the case of momentary distracting impressions occurring immediately before the impression to be registered, it is found that within certain limits the actual order of the impressions may be misapprehended, so that the anticipated impression is observed as co-existent with, or even as prior to, the disturbing element which it in reality succeeds. The fact that in watching a bleeding operation a person sees the blood spurting before the insertion of the lancet is a familiar example of this curious fact. Other interesting results follow when the distracting impression is made to succeed the main impression by a very small interval. If the interval be less than a certain magnitude, and the disturbing impression be of a certain strength, the main impression is extinguished, so to speak. The apperceptual energies are called off by the second impression before they have had time to form a distinct intuition of the first.

It is proved by these experiments, says Wundt, that the precise point of time at which an impression is apperceived depends in a very curious way on the amount of preparatory self-accommodation which the attention has undergone. If a clear and vivid image of the impression be formed beforehand, and if the interval between the revival of this image and the recognition of the actual impression be sufficiently small, then the image and the impression are no longer distinguished, and the instant at which the former recurs is taken for the moment of the reception of the latter.

It is also established by these experiments that attention does not in most cases possess the power of grasping two impressions at the same instant. Where two impressions are simultaneously apperceived, it is because they are such as can be brought under one complex impression as parts of a whole. Further, the activities of attention require a certain interval of time in order to pass from one impression to another. Wundt says that two impressions which owing to the after-effect of the first are perfectly continuous are nevertheless perceived as

two distinct impressions. In this way, he argues, the laws of attention affix a certain discontinuity or discreteness to the flow of our impressions and ideas.

The most comprehensive and important conclusion which Wundt draws from these experiments is that the operations of apperception and volitional reaction are "one connected process," the physiological seat of which is the domain of central motor innervation. Both apperception and the impulse to voluntary movement "are only different forms of volitional excitation," which has its rise in the anterior regions of the cortical substance. Thus these anterior regions are in a double sense the highest, since they not only subserve the regulation of all the most complicated actions, but also assist in the control of the sensory regions themselves.

The author seeks, as we have before mentioned, to apply this conception of attention to the principal phenomena of violent emotion. He thinks the simplest type of an emotional "*Affect*" is given in the action of a sudden impression. A similar result follows when the impression is so powerful as speedily to exhaust the activities of attention. This is illustrated in the case of the asthenic or prostrating emotions. "Passion streams over and finds vent for itself in energetic movements, in those moments in which apperception commands the impression; it acts in a paralysing manner when either the impression suddenly overpowers consciousness, or when consciousness is exhausted by long conflict with the passion." (p. 805.) Wundt thus refers the bodily movements which accompany strong passion to the energetic excitations of the central motor tracts which form the organ of apperception and voluntary movement, and the wearing effect of certain orders of passion, as terror, to an exhaustion of the energies of these motor tracts.

We cannot say we think this attempt to reduce the bodily effects of emotion to mediate effects, namely those which are due to the action of impressions on attention, to be successful. It seems to be contradicted by the fact that the most energetic emotional movements take place in the absence of everything like a consciousness of an exercise of attention, and overlooks the psychological fact, that emotion, as something distinct both from sensuous impression and from volitional impulse, is a species of bodily excitement which shows itself conspicuously in the muscular activities, but which betrays its presence in heightened sensibility quite as much as in increased motor activity.

But passing by this particular application of Wundt's theory of attention, we can confidently say that it constitutes a very

important advance in our knowledge of the real processes of volition, and helps us to understand by what mechanism the mind consciously turns its attention to an internal idea and through a voluntary concentration of its forces, facilitates the processes of sensuous perception. It is the part of the treatise which the psychological student can least of all afford to overlook.

JAMES SULLY.

IV.—CONSISTENCY AND REAL INFERENCE.

It would not be going too far to say that the principal difficulty in the way of a student of Logic at the present day (at any rate in England) consists not so much in the fact that the chief writers upon the subject contradict one another upon many points, for an opportunity of contradiction implies agreement up to a certain stage, as in the fact that over a large region they really hardly get fairly within reach of one another at all. To quarrel upon specific points people must have at any rate some principles in common; where this is not the case, they have little else to do than to make up for the vagueness of their dissent by the vigour with which they give expression to it. Much of the consequent confusion can, we are convinced, be easily allayed by a simple process of intercomparison, provided only the various systems be referred to their leading principles of distinction. In adopting such a plan we need make no apology for confining our attention to the most popular and familiar writers on each side; indeed for such representative purposes they are distinctly the most suitable. But, at the same time, it must be understood that though nominally comparing authors, we are really comparing systems.

That we have not overrated the magnitude of the divergence between the various systems will be evident from a very few extracts and quotations. Hamilton, by implication rather, and Mansel, formally and explicitly, deny that the subject-matter with which Mill is occupied deserves the name of logic at all; they regard it as being nothing more than a somewhat arbitrary selection from Physical Science. Mill in turn gives equally conclusive indications from his side. He declares, when discussing the import of propositions, that the Conceptualist view is "one of the most fatal errors ever introduced into the philosophy of logic." Elsewhere he gives criticisms which amount to the retort that those who adopt that view are making logic nothing more than a somewhat arbitrary selection from Psychology.