

THE GROWTH AND SPIRIT OF MODERN
PSYCHOLOGY.

FOR a time it was thought necessary to write—"modern" psychology, a very proper noun being supposed by this manner of punctuation to shrug at an adjective of doubtful propriety and possibly to shrink from the connection. This need is no longer felt. The advance of psychological studies within the last few years is so decided, and the interest which they have awakened so general, that the inverted commas may now be regarded as superfluous. The adjective itself is retained for the present merely to show that a transition has taken place. Psychology, in other words, has passed into a new phase, and has become to some extent a new fashion.

Those who are familiar not only with the name of the science but with its local habitations as well, are perhaps less numerous than those who watch its development from afar, inhaling psychology from the pages of romance, or catching such glimpses through the columns of the press as make them eager to know more of psychical research. From the intense absorption of the professional worker down to the curiosity of the literary eclectic, there are all grades of interest and of appreciation. But in this way or in that, for one reason or for another, well-informed people keep an eye on the movement. If the mind does not reflect upon itself, it is pleased at seeing itself reflected.

This popularity is due in a measure to certain expressions which have recently become current and which leave wide play to the average fancy. What goes on in a psychological "laboratory?" How is an "experiment" on mind conducted? What sort of apparatus, arithmetic and method is used in mental "measurements?" These are queries that prick the attention more effectually than learned dissertations on analysis, introspection or the relation of soul and body. The new terminology suggests something tangible where all has hitherto been shadowy and vague. It hints at the unveiling of mysteries which have baffled the philosophers of the past. It awakens the hope that science may eventually devise formulas and laws for the world of mind as it has devised them for the world of matter. But the wonder grows when we pass from the modern treatment of normal processes to the equally modern investigation of abnormal conditions. An innate love of the occult seeks satisfaction in all that savors of the preternatural. The in-

terest excited by the *working* of well-determined physical laws is feeble compared with that which many persons, with or without scientific training, manifest in phenomena that seem to transcend all law. Hence the apparent paradox that in an age which is in some respects so materialistic and in others so skeptical, the strange doings of mesmerism and the weird coincidences of telepathy are full of fascination. Indeed, for a large number of minds, psychology is synonymous with hypnotism, faith-cure, and excursions into the world of spirits. It is expected not only to reveal the soul's ordinary *activities*, but also to develop new psychical powers which will heighten the possibilities of life and overleap the barriers of death.

Exaggerated as these notions may be, they are less unjust than the opinion which regards the new science as a finer form of materialism or at best as a chapter in cerebral physiology. "Psychology without a soul" is a phrase often misused to brand, and presumably to crush, the audacious offspring before it is old enough to speak its defence. Nor is censure of this sort blunted when distinctions are drawn between empirical and rational psychology, between established facts and floating hypotheses, between psychology and psychologists. The science still shows its birthmarks, and these are enough to condemn it. For whatever it be, "physiological" or "experimental" or "psycho-physical," it proclaims that it is not metaphysical, and therein lies its chief depravity. Happily, such views are not held by the leaders of the spiritualistic school. The ablest among them, Mercier, Gutberlet and Farges, not only set a proper value upon the results of late investigation, but find a way to bring these into harmony with their philosophy of the soul. Spiritualism, in fact, is endangered more by the downright neglect of research than by the careful study and honest criticism of all that research brings forth. And if to-day its advocates have one thing more than another to regret it is that they have not been foremost in the psychological movement.

The first impulse came from another direction. It originated neither in materialism nor in spiritualism. The starting-point was a truth which every philosophic system must admit but which none can exclusively claim. Likewise, in its subsequent growth, the new psychology, while it advanced steadily to autonomy, by no means discarded as a whole the acquisitions of the past. On the contrary, without the development that preceded, the modern stage would have been impossible. Later on perhaps it will be easy to show that there has been no breach of continuity, and that whatever the outcome may be, the movement itself was amply justified. At present no such perspective is offered us. We are too near the beginning to see things in their true proportions.

But this beginning has an interest of its own inasmuch as it may be considered the boldest effort of exact science, an effort in which by the very nature of the problems involved, thinkers of every school are concerned.

In the outline which follows there is no attempt at a history of psychology. If reference to earlier periods of the science is made, this is only to show that its actual development is in keeping with certain laws which govern the advance of knowledge, and that in many respects the new psychology, though a transformation, is really the complement of the old.

I.

The growth of any science is mainly determined by the nature of the problems which it attempts to solve, and these in turn must vary according to the progress that is made. New results enforce the acceptance of new principles, and, conversely, each principle as it is established opens up unsuspected avenues of research. Sudden modifications affecting the essentials of a science are rare. The point of view shifts gradually, and, in some cases, imperceptibly. By additions to knowledge which in themselves seem slight, by exceptions to what had already the semblance of law, and not unfrequently by the failure of the very hypothesis which prompted investigation, readjustment is brought about, and the course of research is altered.

At times these transformations are the outcome of important discoveries which supply fresh material for observation and experiment. Not only is there a new way of knowing; there is something new to be known. This is especially true of the natural sciences, in which the accumulation of facts is often too rapid for theory and synthetic co-ordination. But such radical changes are not always necessary in order that a science may slip from its traditional mould, and have its problems recast. Different treatment of the same phenomena, implying novel interpretations, detecting hidden dependencies and devising better methods or severer tests, suffices for a thorough renovation. Knowledge in this case advances not so much by widening its domain as by mapping out more accurately its hereditary possession.

The development of psychology conforms to this law of easier transition, and its several stages are marked by different views of well-known facts. Repeated analysis of the human mind has not brought to light faculties or processes essentially diverse from those which Aristotle's keen introspection perceived. But in the course of time other meanings have been attached to mental phenomena and other relations pointed out, necessitating a change in the psychological problem.

In the Peripatetic system, both ancient and mediæval, the functions of mind were chiefly studied and valued as manifestations of the underlying soul. *Operatio* being the index of *esse*, thought and volition were understood and described in the terms of metaphysics, while the substance which they revealed took its place in the magnificent scale of being which descends from Deity to the film of "first matter."

It is true that among the later Scholastics we find thinkers who deviated from the traditional methods. Buridan, in the fourteenth century, may be fairly said to have approached the line of research which psychology follows at present, and to have enunciated principles which are now receiving experimental confirmation. But in his day philosophy was already on the decline. The thought of the age was drifting rapidly towards mysticism on one hand and the classicism of the Renaissance on the other. The old rivalry between the disciples of Aristotle and those of Plato was renewed, and a feverish activity with little or no result prevailed. Then came the storm of the sixteenth century.

The earliest psychology of England, taking its key-note from Locke, is decidedly empirical. And yet, as the "Essay" clearly shows, its dominant purpose is not the investigation of mental processes for their own sake, but the construction of a theory of knowledge. Sensations and ideas are principally studied, insofar as they represent external phenomena, and form the links between subject and object. Here, then, we have a new problem, and in its attempted solution a new version, so to speak, of conscious facts. The tendency, however, is still philosophical, and the main issue, though of undoubted importance, complicates, rather than lightens, the task of psychology. England's share in preparing the way for the modern science of mind consists, above all, in Hartley's revival of the Aristotelian theory concerning the association of ideas, the elaboration of which has been the favorite occupation of English psychologists from Hume down to Spencer and Mill.

In Germany the development of scientific psychology was still more tardy. From Leibnitz to Kant speculation is busy with those essential problems which demand a solution from every philosophical system, and becomes more and more involved as the haze of abstraction thickens and draws thought away from reality. To the German schools of the seventeenth and eighteenth centuries psychology's debt is trifling. The "monads" are scarcely a substitute for the forms of Scholasticism, nor is the "pre-established harmony" much more satisfactory than the "influxus physicus" of Descartes. Inquiry into the elementary functions of mind was neglected, and if among the "popular philosophers" healthier germs occasionally appear, these certainly did not mature.

Kant himself declared that psychology could never become an exact science; first, because mathematics could not be applied to mental processes, since these must take place in time, and be limited to a single dimension; secondly, because experiment upon other minds, and the profitable observations of one's own conscious states, are equally impossible. To the first of these reasons Herbart replied with a "mathematical psychology," based on the fact that states of consciousness not only follow each other in time, but also vary in their intensity, and, consequently, are of two dimensions. This was a step in the right direction; and the principle on which Herbart insisted has survived, though his theory of mental "inhibitions," and the formulas in which they were expressed, have rather an historical interest.

Kant's second objection was more serious. We have no such instrument as a psychoscope, under which mind can be placed and examined. All that we learn, beyond mere surmise, of what passes in the consciousness of another, is revealed to us by such corporeal functions as action and speech. Whoever, on the other hand, is accustomed to introspection, must know how hard it is to seize and examine his mental states methodically. There is less difficulty in holding a drop of mercury beneath one's finger. And when, of the many who study their own minds, no two are found to agree, to what tribunal must these "private judgments" be brought? Had Kant lived to see the development of philosophy during this century, he would certainly have enjoyed some rare results of introspection.

He would also have regretted his prediction concerning psychology. For, in spite of all this philosophical oscillation, the natural sciences were forging ahead, slowly, but on definite lines. From mere description they advanced to measurement, from qualitative analysis to quantitative determination. Physics and mechanics, going hand in hand, were the first to reach mathematical exactness; but, according as their principles and methods were applied to the study of organisms, physiological research became in its own way quantitative as well as qualitative. Organ and muscle and nerve were known not only to perform certain functions, but to perform them with an energy and a velocity which might be precisely ascertained. Vital processes, in other words, even those which minister most directly to the operations of mind, were found to observe laws already verified in the inorganic world.

Again, many of the discoveries accredited to physics and physiology were, in a manner, contributions to psychology. Every advance in optics and acoustics implied a better knowledge of the conditions by which vision and hearing are determined. Newton, splitting the white ray into its colors, and Helmholtz analyzing tone, do as much for the investigation of the senses as for that of their

respective stimuli. Nor could physiology—as it studied the functions of eye and ear, as it traced excitation from periphery to centre, as it followed motor-impulse along its efferent path—do less than throw light on the intricate processes which parallel sensation, thought, and volition. Thus, while they furthered their own particular aims, these sciences approached nearer and nearer to the domain of psychology, and elaborated for its use invaluable data.

What is more, the close observation and delicate experiment of physicist and physiologist involved psychological problems. In roughly estimating his results, the scientist might, and often did, neglect the possible errors for which the organs of sense were responsible. But, for nicer determination, these variable factors, which even a perfect apparatus cannot eliminate, have to be taken into account. Not alone in astronomy is the “personal equation” of importance; allowance must be made for it wherever and whenever exact registration is demanded of the observer, or the greatest possible uniformity desired. Add to these conditions of method the fact that numerous phenomena with which physiology deals must receive their final interpretation from psychology, and it will be readily understood how the boundaries of these sciences overlap.

In a wider and more philosophical sense, biological research for a century past has been guided by principles which could not but modify the study of mind. Underlying every theory of evolution is the idea of a continuous development, resulting in gradual differentiation. To trace this process back to its earliest stages, a comparison of structure and function all along the series of organisms was required. Hence, the genetic method and, as essential to it, the comparative method. That both can be applied to the investigation of mental phenomena, and made to subserve the needs of a system, is abundantly evidenced by Mr. Spencer’s “Principles of Psychology.” But such forced philosophic adaptation does not lessen the value of those methods for empirical research. On the contrary, with due precaution and watchful criticism, they may become welcome aids to psychology, and indispensable aids where introspection and experiment are alike unavailing.

The outcome of these influences is that the psyche may now be regarded and studied in two ways. As the principle of mental activity in man, it is treated in “individual psychology” and, so far as is possible, by experimental methods. To its investigation in a wider sense, as embracing all forms of consciousness, “comparative psychology” is devoted. The purpose of this article is to sketch the growth, the methods and the achievements of experimental psychology.

II.

If we had to choose a maxim of the philosophers as a motto for psychological investigation, none would be more apt than *Nihil in intellectu quod non fuerit prius in sensu*. Whether with one school we hold that between the lowest and the highest mental functions there is a difference of kind or, with another school, that there is merely a difference of degree in complexity, certain it is that sensation is the starting-point of the whole process. Both those who regard ideas as products of an essentially superior activity and those who see in them nothing more than a transformation or synthesis of sense-percepts, must agree that sensation is, in some way, the elementary operation of mind. Standing thus in the gateway of mental life, it is the first to challenge examination. But there are obviously special reasons why the so-called "inferior powers" should have the priority in experimental research. To the very essence of experiment it belongs, that we should be able to vary its conditions at will, and to keep them under control. Now it is true that we cannot grasp the mind and hold it up to external agencies as we hold a mirror before a candle. We can, however, shift the candle about, that is, we can vary the objective impression and catch its reflection in the judgment pronounced by the mind and note how far impression and judgment coincide.

Ordinary experience teaches us that the coincidence is not always perfect. In "measuring with the eye," in testing with the tongue, and in discerning with the ear, we are liable to mistakes. And this tendency grows as we descend from the estimate of great differences to the perception of those that are trifling. Most of us are content to observe these facts, to note them as "curious," and to dispense with further investigation. The scientist does more. What for others is insignificant may be to him of prime importance; and what they look upon as an isolated peculiarity may give him an inkling of a more general law. So it has happened in psychology.

Two separate impressions upon the skin or upon the retina, in order to be perceived as separate, must be at a certain distance from each other; the mere fact that, objectively, there is an infinitesimal space between two points is not sufficient for their subjective distinction. Again, the discrimination of two impressions, the heaviness of two weights or the length of two lines, depends, not upon their absolute but upon their relative difference. E. H. Weber was the first to observe these facts of perception and to deduce from them the principle that in comparing external impressions, we are able to determine their relations, but not their absolute value. This was in 1834.

Calculations looking in the same direction had already been

made for other sense-functions and from other points of view. In 1738, Bernouilli established the dependence of the *fortune morale*, or pleasurable feeling, upon the *fortune physique*, the outer stimulus. A year later, Euler showed the connection between our perception of tone-intervals and the numeric proportions of the air-vibrations which are the physical cause of sound. Important, however, as these reckonings were, and necessarily bearing upon the relations between physical and psychical processes, they were not merged in any general law. The same must be said of the photometric experiments which have given Steinheil, Bouguer, Arago and Mas-son their scientific fame; their results were of narrow application, or at any rate were not interpreted on psychological principles. To group these loose-lying data, to give them their true significance, and to make them the starting-point of a more complete and more systematic investigation, was the task reserved for a man who united in himself the qualities of physicist, philosopher and mathematician. This man was Gustav Theodor Fechner.

In an historical chapter at the close of his "Elemente der Psychophysik," he sketches the development of the ideas embodied in that work. Imagine a man, he says, standing at a point in the circumference of a circle and looking for an object which lies within a step of him but behind his back. All round the ring he plods until at last, coming upon what he sought, he realizes that a simple turn of the head would have spared him his trouble. Such was Fechner's own experience. The purpose with which he set out was the discovery of a functional relation between soul and body, or, to express it in more general terms, between psychical and physical phenomena. This he did not conceive either as the union of form and matter or as a harmony in the Leibnitzian sense of the word, but as something analogous to physical determinations. Physics had shown the dependence of color and tone upon their external causes. Fechner sought the relation between sensation and the internal physical processes with which it is so intimately connected. In other words, his object was to find a measure for psychical phenomena, to determine their intensity as well as their quality.

This concept implied evidently a resetting of the psychological problem. As indications of the substantial soul, as reflections of the outer world, as phenomena gathered in groups or ranged in sequences according to definite laws, mental states had long been the subject of investigation; but no attempt had been made, so far as Fechner knew, to show the quantitative connections which, in the sphere of consciousness, parallel those which rule organic functions.

Inviting, however, as the problem was, its solution demanded

both reflection and research. Fechner's first idea was that soul and body, or their respective operations, might stand to each other as arithmetical and geometrical series of a lower order to those of a higher order. As a schematic illustration, this manner of conceiving the relation was not altogether unsatisfactory, but it needed sharper definition. Still clinging to the geometrical series, Fechner was led by a roundabout of thought to the conviction that the *relative* increase of the bodily *vis viva* should be taken to measure the increase of the corresponding mental intensity; and that as the *vis viva* on the corporeal side might be conceived as resulting from a summation of absolute increments, a similar summation could be assumed on the psychical side.

This view was more precise, and furnished an interpretation for certain facts which earlier investigators had discovered. But the goal was not yet reached — the psychical measure was not yet fixed upon. It was, of course, clear that a unit of measurement, such as the metre for distance or the gramme for weight, could not be found for mental quanta. We cannot say that one sensation of light is twice as strong as another, or that one sound is three times as loud as another. What we perceive is that the impressions differ in intensity or seem to be equal; that they increase or decrease; that there is an under-limit below which stimuli produce no sensation, and an over-limit beyond which an increment in their strength is not noticed. Why not make these variations of perception, with due verification and appropriate formulas, the basis of psychical measurement? This was the question which Fechner proposed to himself and, later on, to a scientific friend, from whom he received the answer that the idea was a good one and might even become a happy one provided it could be demonstrated and supported by facts. The suggestion bore its fruit. By patient research and with Volkmann's assistance, Fechner not only gathered the data which he needed, but also opened up a perspective, extending far beyond his individual attainment.

It was in the course of this quest after facts that he learned of Weber's work in the same line; and though he did not regret his laborious progress round the circle, he was so impressed with the achievements of his forerunner that he attached Weber's name to the law for which his own results are the chief basis. "Weber's law," then, was reduced to this form: equal absolute increments of sensation correspond to equal relative increments of the stimulus, or, as it has since been expressed, the stimulus-strength must increase in a geometrical ratio if the strength of the sensation is to increase in an arithmetical ratio. If, for example, one-third of an ounce must be added to an ounce in order to produce a barely perceptible difference of sensation, then two thirds must be added

to two ounces, three-thirds to three ounces, and so on, in order that an increase in weight may be noticed. The increment, in other words, must bear a constant proportion to the original stimulus with which the strengthened stimulus is compared.

We thus obtain not a direct but an indirect measure of sensation, the precision of which will depend partly on objective, partly on subjective, factors. Supposing that the physical conditions of stimulation are exactly determined, and that the attention is fully alert, it is possible to experimentally construct a scale in which each new degree of excitation will have a corresponding reinforcement of sensation. The lower limit of such a scale Fechner called the "threshold," adopting for sensation a term which Herbart had introduced to designate the entrance of a presentation into consciousness. Once we rise above this liminal quantity, we pass by "just observable differences" to a maximum beyond which objective additions are no longer remarked. The increment which a given stimulus must receive in order to effect such differences was styled by Fechner the "threshold of discrimination."

A gradation of this sort is obviously impossible without methodical procedure. If this be wanting, no skillful manipulation of apparatus, no flashes of genius or quickness of observation, can supply the defect. The next step, therefore, which followed upon the formulation of Weber's law was the adoption of the so called "psycho-physical methods." Here, too, Weber had led the way; but for wider application of the methods and especially for their theoretical discussion, Fechner's work cannot be too highly praised. Sensations of light, of tone, of pressure, and of temperature were in turn subjected to experiment, the various results expressed in mathematical terms, and even the philosophical bearings of these new data thoroughly set forth. The outcome of all this research was the "*Elemente der Psychophysik*," which made its appearance in 1860, just ten years after its fundamental idea took shape in the author's mind.

Fechner was far from exaggerating the merits of this work. In his preface he warns the reader that what follows is not an exposition of the elements of a science already well under way, but the presentation of an embryonic stage in what he hopes may become a science. Nor is he less circumspect in estimating the results which he obtained. Repeatedly he protests that further investigation is needed to fully elucidate the problems in hand, and even suggests how his own work may be improved. If, as is now generally thought, he overrated the importance of Weber's researches, and imputed to Weber's law a value which subsequent tests do not confirm, his right to be called the founder of the new psychology is none the less secure. Apart from what he actually

accomplished in regard to principle, method and experiment, his title rests on the fact that he marked out new lines of research which prove more and more fruitful as they are developed. Whatever may be the verdict of posterity upon the contents of the "Psychophysik," its *suggestiveness* can never be called in question.

The discussion which it provoked has proved a help rather than a hindrance to the attaining of Fechner's chief purpose. It gave him, also, occasion to bring out more clearly various points of detail which, as expressed in the original treatise, were open to misconstruction. The last, and perhaps most satisfactory presentation of his views was published shortly before his death. Out of a life of eighty-six years, about forty had been devoted to psychological research, whose stimulating effects were plainly visible when Fechner, in 1887, ceased from his labors.

Others, in fact, had entered with ardor into the same field. As early as 1862, Wundt, in his "Beiträge zur Sinneswahrnehmung," had spoken of an "experimental psychology," and in his "Vorlesungen über die Menschen-und Thierseele" (1863) had plainly outlined the course to be pursued in his later research and publication. The work, however, for which we are most indebted to him is his "Grundzüge der Physiologischen Psychologie," the first edition of which appeared in 1874. The term "physiological" is significant not only as specifying the author's treatment of mental processes, but also as hinting at differences of view between Wundt and his predecessors. In determining the relations of psychical and physical phenomena, we may confine ourselves to the two extremes, viz., the outer stimulus and the resulting state of consciousness, without attending to the physiological media which intervene. The color-sense, for instance, may be studied by experiments in which various degrees of saturation are compared with the subjective impression, but in which no note is taken of what goes on in retina, nerve and brain. Fechner's investigations were mostly of this class, and belong to what he termed the "äussere psychophysik." It is true that his "innere psychophysik" is an attempt to account for the intermediary organic processes, but much remained to be done before this aspect of the problem could be handled in a manner befitting its importance.

Wundt's psychology is based on the idea of a complete parallelism between psychical and physiological processes. Corresponding to every function of mind there is a function of the nerve-elements. External stimuli acting upon appropriate organs and passing along definite channels, set up changes in consciousness, and, conversely, changes in consciousness modify organic activities. Nerve-processes, as such, are investigated by physiology; mental processes, as such, by pure psychology, and the

study of neuro-mental processes belongs to that border-science which is called "physiological psychology." It is evident that Wundt follows the same general line of thought as Fechner, but that at the same time he more closely determines the problem which inspired the "Psychophysik." The remarkable additions to our knowledge of the structure and functions of the nervous system which have been made during the last three decades, and in which Wundt himself has had a share, confirmed him, no doubt, in his view, and, to some extent, facilitated his task. He has, however, insisted—and with good right—that the fields of physiology and of psychology are distinct, and that the latter, though deeply indebted to the former, has a scope and a method of its own. In psychological experiment it is important that the physical conditions should be accurately fixed and varied; otherwise, definite results are impossible. Nor can an outer stimulus be properly applied, and its effects adequately understood, unless physiological factors be taken into account. But supposing these requirements entirely fulfilled, we have yet to take note of the essential element—that is, of what happens in the mind. The mental process is known to the experimentee alone, and to him only by self-observation. Were introspection infallible, its report, without further check, would be decisive. Such, however, is not the case. Deception glides so easily into our scrutiny of mind, especially where slight variations are to be detected, that rigorous control is needed in order to obtain anything like a precise record of our inner experience. This control is secured by experimental methods, and is more severe in proportion as they are perfect. Modern psychology, then, far from setting introspection aside, imparts to it a value which it could not otherwise possess, and for want of which it has served too often as a basis for inexact or erroneous conceptions.

Hence it is that immediately upon beginning its research the new science busied itself with testing its methods. By comparing the results which they severally give, by adapting them so far as may be necessary to various lines of investigation, by pointing out and if possible by eliminating conceivable sources of error, it is gradually enabled to assign each its proper value. The sharpest criticism and the nicest calculation have thus been called into requisition, and though the work is by no means at an end, it is assuring to see that one great mistake has been avoided, that, namely, of pressing on blindly without stopping to ask if the course had been rightly set.

The worth of a method may be, in part at least, determined by an examination of the principles upon which it is based. Its flaws

and shortcomings may appear on a moment's reflection, or be detected by a simple calculation. Undue assumption, neglect of minute but important factors, hasty deductions and unwarranted extension which tend to vitiate a method, or limit its application, are often exposed by critical treatment. The ultimate test, however, is experiment. Even a method that in theory is sound may be rendered impracticable by reason of special conditions that bar its application. Corrections, on the other hand, which no amount of speculation could suggest, occur at once to those engaged in experimental research. To organize such research was one of the first steps taken by Wundt.

In 1879 he opened a laboratory of experimental psychology at the University of Leipzig. The undertaking was not without its difficulties. Space was wanting, appropriation was slow, and some of the on-lookers shook their heads in doubt first as to the legitimacy of such an institute and then as to its chances of success. However, a small band of workers gathered round the director, and under his leadership made a vigorous beginning. Results were soon obtained which justified the publication of a special review, and in 1881 the "Philosophische Studien" appeared. Wundt's initiative was speedily followed in other German universities, and psychological laboratories were founded at Göttingen, Berlin, Freiburg and Bonn.

Among the earliest members of the Leipzig institute was G. Stanley Hall, who introduced the new method into this country by establishing a laboratory at the Johns Hopkins University in 1888, and by publishing the "American Journal of Psychology," which is now in its sixth volume. At present there are fifteen laboratories in the United States, and the number will be increased in the course of this year. In January, 1894, Profs. Cattell and Baldwin issued the first number of "The Psychological Review" which counts among its contributors the leading psychologists of this country and of Europe. Add to this list of periodical publications the "Zeitschrift für Physiologie und Psychologie der Sinnesorgane" edited by Ebbinghaus, of Berlin, and it will be easily seen that literature on the subject is not lacking. Finally, to encourage psychological work, an International Association has been formed, which has met twice, at Paris in 1889 and at London in 1892. Nearer home we have the American Psychological Association, which held its first meeting at Philadelphia in 1892 and its second at New York in 1893. In little more than a quarter of a century, Fechner's prediction has been fulfilled; experiment has succeeded to mere introspection, and psychology is as much at home in the laboratory as it was in the library.

III.

To the question, What has been accomplished? the simplest reply would be—*consule probatos auctores*. For those who have not such works at hand, an outline may possess some interest. But in any case, it is well to remember that the science is still in its infancy and that it makes no pretension to rival the acquisitions of older branches. Nor is it less necessary to keep in view a feature of research which is often misunderstood. Minuteness, detail, insistence upon microscopic elements and conditions—all this, most people allow, is a splendid proof of patient perseverance; but, *cui bono*? So-and-so has spent months, perhaps years, in proving that the lateral retina is less sensitive than the *fovea centralis*; some one else has written a volume on the temperature-sense, or the perception of tone, or the time-rate of various sensations. What does it all mean and what does it tell us about the soul? These are not fictitious queries. They suggest themselves naturally and are constantly proposed, not only by laymen but also by others in whom the synthetic tendency is impatient. In this respect, of course, psychology is no worse off than other sciences. What the world cares to know from the chemist, the physiologist, and even the historian is the “grand result,” not the sifting and drop-by-drop accretions which it supposes. And yet as in every department of knowledge the advance is by inches more often than by miles, so in psychology the truest progress is seemingly slight. Whoever undertakes the solution of a problem which at first sight appears to be simple will generally find on closer view that it is exceedingly complex. As his investigation proceeds, he remarks that a trifling variation in the conditions of experiment produces unexpected results, each of which must be fully accounted for before he can safely pursue his way. Obligated thus to “divide and conquer,” he narrows his plan of research until at the end his labor, though thorough, is spent upon a tithe of the original task. In other words, he has been busy with analysis, and the outcome is merely a thread in the fabric of science which jointly with others he is weaving. But results are multiplied, and adjusted by criticism, and reinforced by comparison till at length, by masterly synthesis, they are fashioned into theory and law.

No satisfactory generalization of this kind has yet been arrived at concerning the main problems of experimental psychology. It is now acknowledged, that in consequence of repeated tests, Weber's law possesses only an approximate value. It is verified in regard to auditory sensations, but receives little or no support from investigations on the other senses. Wundt, in this connection, calls attention to the fact, that in each sense-organ peculiar physiological conditions exist which help to explain deviations

from the law. Every one, for instance, is familiar with the phenomenon of adaptation which plays so important a part in our sensations of light and of heat. This evidently renders the "threshold" unsteady, and thereby interferes with experiment. The same must be said of after-images, of sensations that are subjective in their origin, and of the fatigue that invariably arises when an organ is exposed to stimulation for any considerable length of time. Whether by making due allowance for all these factors we get any nearer to the real psycho-physical relation is a question that future research must decide. For the present it is worth while noting that each of these peculiar conditions which threatened at first to block the course of experiment have rather widened and extended it. If adaptation foils us in the observation of visual impressions, we can turn about and study adaptation itself. If after-images are as troublesome as they are irrepressible, they can at least become subjects of inquiry, and sources, perhaps, of new knowledge. Whenever, in a word, exceptions occur that tend to invalidate a law, they must be traced to their causes and turned to the profit of science.

It is, moreover, to be remarked, that though Weber's law, in the precise form which Fechner gave it, has not been fully verified, its underlying principle admits of no doubt. We are certain that sensation does not ascend in intensity with every increment of the physical stimulus. How is this fact to be understood? At some point in its passage from the outer world to mind, the impression evidently spends part of its force. On the other hand, its appearance or non-appearance in consciousness as a new intensity depends in some way on the amount of stimulation by which it is preceded. Two explanations are thus offered which, differ as they may in some respects, imply no essential contradiction. Adopting the physiological point of view, we may say either that the neural excitation does not keep pace with the increasing stimulus-strength, but rises more slowly; or, that feeble excitations, though fully transmitted through organ and nerve, become latent in the gray matter of the brain, and have to accumulate before they can arouse sensation. In this case the mental process is directly proportioned to the stimulus to which it responds, but the stimulus itself is diminished at the periphery, along the afferent path or in the cerebral centres.

According to the strictly psychological interpretation, the phenomena which we seek to explain are merely instances of a more general law, the law of the "relativity of our conscious states." Every process of mind has its value determined, not by any absolute measure, but by its relation to contiguous processes. Besides the neural transmission, and besides the sensation as such, there

is our estimate of the sensation or, as it has been termed, the process of "apperception." It is by this process, says Wundt, that we compare different amounts of sensation, and since the basis of comparison is the sensation as presented in consciousness, our judgment must depend as well upon the actual condition of consciousness as upon that of the neural substance. Because also the excitation of the apperceptive centre implies a physiological process, this second interpretation harmonizes with the other and raises it to the rank of a higher principle by which our mental life is governed.

Both views, in the course of discussion, have found adherents and opponents. Both start out from incontestable facts to explain a phenomenon which is a complex of psychical and physiological elements. So far it is certain that neither can be exclusively accepted, and it is probable that both will be modified by further investigation. We have yet much to learn in regard to cerebral functions, and until these are more thoroughly studied, hypothesis must enter largely into our interpretation. On the other hand, what we call "consciousness" includes a great deal more than mere sensation. Feelings in the stricter sense of the word, associations, logical combinations, acts of memory, attention and will, all have their share in our mental "structure," and all must be accounted for before psychology can venture on its final generalization.

Some progress has already been made in the experimental investigation of these higher processes; but it seems advisable here to render our description of them more intelligible by a brief outline of the course pursued in obtaining such results. A thorough acquaintance with psychological methods is to be gained only by personal experience in the laboratory; and if the present sketch is no attempt at a pen-picture, it may serve to show how the difficulties of research, though numerous, are in a measure overcome.

Once a problem is well defined, the first step towards its solution is the arranging of physical conditions. The stimulus must be kept under exact control, its quantity ascertained, its constancy within necessary limits secured, and its variations precisely determined. For this purpose apparatus is needed which must be delicate in proportion as the work approaches a maximum of niceness. In some lines of experiment, instruments ready-made are found in the ordinary physical or physiological cabinet; in others, special contrivances are devised to meet special requirements of the problem. And in all cases the arrangement is considered more perfect according as the apparatus, by acting with mechanical precision, excludes the uncertainties of manipulation. A candle-flame, for example, is not the best source of light, nor would the

highest skill of a pianist ensure a perfectly regular sequence of sound. Experiment, to be worth anything, must adopt more accurate means.

Of equal, and perhaps of greater importance, is the selection of an experimentee. Not every intelligent or educated person will answer this purpose. The subject, potentially at least, must be capable of close introspection ; that is, if he does not already possess this habit, he should be able to acquire it by a reasonable amount of training. For it is intended not that stimulation shall sink silently into the depths of his consciousness without eliciting a response, but that he shall describe with the greatest possible accuracy the effect of the impression upon his mind. In drilling the novice, however, certain errors have to be avoided, which are occasioned at times by an over-anxiety to get uniform results, or results that bear out a preconceived notion. He should not be given the *à priori* idea that a standard exists to which his own report must correspond, nor should he be urged on by practice to become a machine. Failure to act mechanically is a defect in a piece of apparatus ; in the subject of experiment it hints at some particular feature of consciousness which in itself demands explanation.

Proper apparatus and capable subjects are essential requisites for successful work. But in actual experiment many details have to be taken into consideration in order to ensure methodical precision. In most cases, for instance, the experimentee must be isolated as far as possible from all disturbing influences, so that the full force of attention may be given to the impression which is under investigation. Hence the use of the "dark room" in optical work, of the "still room" in experiments on hearing, and of many more delicate contrivances which not only exclude impressions upon organs other than the one which is being tested, but also limit the action upon a particular organ to a single stimulation. Again, in certain lines of work a choice must be made between informing the subject of what he is to expect or to observe, and leaving him in partial ignorance. The latter plan is often preferred because it frees the observer from bias, and checks the tendency to routine. In fact, this choice implies something more than a methodical precaution ; it involves the problem as to how far anticipation affects our estimate of an impression. Another question that presents itself at the outset is this : should the experiment be repeated a great number of times upon two or three subjects, or should a score of subjects be tested with fewer experiments for each ? If the first plan be followed, the results will approach constancy more and more, and may be regarded as typical in certain kinds of research. But when we have reason to believe that individual dif-

ferences will be considerable, these can be reduced and something like an average obtained only by increasing the number of experimentees. It need not be added that the time required for getting satisfactory results will depend in great measure upon the way in which this question of method is answered.

Let us suppose that with due regard to these and other details, a piece of work has reached a stage at which the facts observed point to a definite conclusion. If we look over the record of these experiments all that we see at a glance is a succession of ledger-like pages covered with rows of figures, with here and there a mysterious sign or a brief annotation. To the unpracticed eye these protocol symbols mean nothing; nor do they mean much more to the psychologist until by proper interpretation their teaching is set forth, their variation ascribed to changing conditions, and the fact which they enunciate traced up to its cause. To obtain results by proper methods and to give such results a just interpretation—these are the main elements of research and the means of adding to our scientific knowledge.

The psychological problems which have thus been handled are by no means exhausted; yet their treatment is of sufficient interest to justify at least a hasty review.

1. *Analysis of Sense-Perceptions.*—Impressions made upon our organs of sense give rise not only to single sensations but also to those more complex states which the Germans designate as *Vorstellungen*, and which we with less precision call "presentations." Habitually we regard these combinations as simple processes, so closely are they welded by experience and so rapidly, almost automatically, are they formed. On nearer examination, however, we discern in them a large number of elements brought together in a variety of ways and under conditions which usually pass unnoticed. Nor are these elements and conditions identical for all our perceptions. In visual presentations, for instance, spatial relations play the leading part; in auditory presentations the time-element predominates; while in tactile and motor presentations both space and time are involved. One set of impressions is simultaneous, another successive. One is easily localized, another scarcely hints at the place whence, objectively, it proceeds.

Considerable progress has been made in the analysis of presentations whose elements are furnished by the highly developed senses of hearing and sight. The nature of musical intervals, of rhythm, harmony and melody, has been carefully defined. Still nicer work has been done on the visual field, the perception of motion, distance and perspective, and the curious phenomena of optical illusion. But in regard to taste and smell and *a fortiori* in regard to hunger, thirst and fatigue, our knowledge is meagre and

unsatisfactory. So that while the mental ordering of impressions that chiefly acquaint us with the outer world, has been thoroughly investigated, the nature of those perceptions which are immediately connected with the sustenance of the organism or arise from systemic conditions, is still quite obscure.

2. *The Study of Attention.*—Objects within the field of vision are more or less clearly seen according to the retinal points which they impress. If their images fall upon the lateral retina, the corresponding objects are indistinctly seen. The object which darts its ray to the *fovea centralis* is perceived with greatest distinctness. Something analogous takes place in the mind. Of the sensations, perceptions, thoughts or feelings that enter at a given moment into the mental content, but one is at the focus of attention; the rest are stationed in the outlying area of consciousness. By what means is this mental fixation brought about? Under what conditions does it veer round from one image to another? How far does it yield to the force of external impressions or the drift of association, and how far is it under the control of the will? Is it steady or fluctuating? Does it weary with anticipation, grow firm with long repetition or spring up at sudden surprise? The answers both qualitative and quantitative that experiment has given to these questions, are among the best contributions to our knowledge of mind.

3. *The Succession of Mental States.*—That feelings and ideas group themselves in definite ways, and that if not interfered with, they follow each other in a certain order through consciousness, are facts which have long since been reduced to the "laws of association." Succession, however, implies time, and time can be measured. It is possible, then, to determine in some way the duration of mental processes, to estimate how long it takes to see, to hear, to judge, to choose. It would, of course, be useless to attempt measurements of this kind upon our ordinary speed of thought. At times we think with remarkable rapidity; at others, our ideas seem to drag; and again when a choice is necessary, the swarming of ideas is a cause of hesitation. The conditions, therefore, of the problem must be simplified to such a degree that the whole force of the attention is centred upon a single impression or limited to a small number of impressions. We may then determine, not how long it takes the mind habitually to act, but how quickly it can act under the most favorable conditions. This action, moreover, cannot be directly measured. As impressions reach the mind through the organism, the response must travel back through some organic process in order that it may be registered. Knowing the time-point at which the impression was given and that at which the mental process is recorded, we have an interval which is filled

up with a series of actions, partly physiological and partly psychical, and which is usually called the "reaction-time." This interval, in its totality, is easily measured. We wish, for instance, to know how long it takes to hear. The same stroke of the hammer that produces the sound closes an electric circuit and sets the chronoscope in motion; the experimentee, on hearing the sound, opens his telegraph-key, breaks the circuit and brings the chronoscope to rest; the dial shows that so many thousandths of a second have elapsed. But meanwhile a number of processes have taken place. From the ear, the sound-stimulus has sped along the nerve to the brain, acts of recognition and volition have been performed and a motor impulse has hurried back, forcing the muscles to contract. Were all the physiological factors in this plexus accurately measured, a simple subtraction would give us the time occupied by the psycho-physical process. In point of fact, however, we are not yet certain as to what takes place in the brain and much less as to the duration of its functions. What we measure in this case is the mental act plus the afferent, central, and efferent neural transmissions.

But this measurement serves a purpose. Given the time required for a single perception, it is possible to determine by further experiment the time taken up by more complicated mental operations. When the subject is obliged to choose between two impressions, to perform a calculation or to associate an idea with the present perception, his reaction will naturally be longer than when he merely hears a sound or sees a light-flash. The record will show a certain time-surplus, and this is properly assigned to the additional process of mind.

In all such experiments, we may expect a considerable variety of results, according to the method employed, the amount of practice, the degree of concentration and the individual constitution. Partly by multiplying the experiments, partly by accounting for their variations, something like uniformity is obtained. But over and above the determination of the mental time-rate, these researches have brought to notice many of those subtle conditions whose influence upon consciousness is as important as it was hitherto unsuspected. And though the labor of analysis is tenfold increased, it is certain that the value of the corresponding synthesis is proportionately enhanced.

4. *The Time-Sense.*—The investigations just mentioned are a reply to the question—what is the time of our thought? Conversely, we may ask, what is our thought of time? The one problem turns upon the duration of mental acts; the other upon the character of the act by which we estimate duration. In a large way, we all know that objectively equal time-lengths seem longer

or shorter according to our circumstances. On the clock-face an hour is always sixty minutes; but in grief or suffering or suspense, each minute for us is an hour, while for our seasons of pleasure and joy, the hours themselves are too swift. The subjective factors in our estimate always overweigh when they are strengthened by emotional states. If these latter be excluded, we are more likely to coincide in our time-judgment with the objective measure. This judgment, however, in order to be accurate, supposes a due concentration of the attention, and as this cannot be held steady through long periods, comparatively brief stretches are alone available for experiment. It is safer, in other words, to compare seconds with seconds than hours with hours. Hence the problem of the time-sense may be restated as the "valuation of short intervals."

Under these limitations, research has of late made remarkable progress, establishing, along with other peculiarities of our time-estimate, the noteworthy fact that shorter intervals are overrated while longer intervals are underrated. This result becomes in turn the starting-point of fresh investigation from which we may hope a clearer insight into what is still one of the most intricate psychological problems.

5. *Feelings and Emotions.*—Here we come upon psychical processes which seem at first sight to elude experiment. Largely as they enter into everyday life, and familiar as they are in various forms, they mock at qualitative introspection, to say nothing of quantitative determination. We never mistake a thrill of gladness for a pang of sorrow nor the promptings of hatred for those of affection; yet sharp-eyed analysis is needed to tell us in what these opposite feelings precisely consist. That they color our thought and affect our volitions and often assert their influence in our outward actions, is also a fact of experience that complicates the problem while it presses for an explanation. It is true that these states are shared in, more evidently than the intellectual activities, by the organism, and from this it might be inferred that their nature could be more easily determined. Emotion when it is freed from restraint reflects itself in our exterior, in the flash of the eye, the quivering of the lips or the flush that spreads over the face. But these outward signs are too vague to form the basis of exact mensuration. They tell us of anger, but not of its degree, of fear and shame and delight, but not of their intensities.

In spite of such difficulties, investigation has been busy, since the first decade of this century, upon the relation between emotion and its bodily expression. From Bell (1806) to Darwin (1872), a lively interest was manifested in the subject, and much valuable material accumulated, which however is chiefly of an

anatomical and physiological character. More attention has been recently paid to the psychological features of emotion, without of course neglecting its externalization. Respiration, heart beat, and increase of volume in different members of the body, have each in turn served as indices of the parallel feeling. The latest researches are by Lehman and appear in his work—"Die Hauptgesetze des Menschlichen Gefühlsleben" (1892). By combining the three classes of movement referred to above, this author has succeeded in giving a graphic representation of various emotions so far as they affect the respiratory and circulatory processes. If we conceive mental calm as a straight line or as one whose rhythmic curvings are as regular as the normal pulse allows, any brusque emotion will trace a sudden excursion above or below the line to an extent that depends upon the strength and nature of the emotion. What is more, the curve will vary according to the kind of ideas that arouse or accompany the most moderate feeling; and no other psychological experiment is so striking as this, in which we can literally follow the "train of thought," or note the ebb and flow of emotion.

In a summary like this it is impossible to do justice to individual psychologists whose researches on particular subjects have been epoch-making for the science. Beginning with the work of Ebbinghaus on memory and that of Goldscheider on the temperature-sense, a long list of names might be added to the roll of honor. Nor have there been wanting in these latter years men who, like Müller and Münsterberg, James, Külpe and Ladd, have proposed to set psychology on new theoretical foundations or thoroughly to revise its methods. All such movements, be their ultimate value what it may, are signs of earnestness and activity. But there is one means by which, without lengthy description, an idea may be given of the proportions which psychological research has attained. Glancing over the *literature* of the science for four years only, we find that the number of publications dealing in one way or another with problems of mental life was, in 1889, nine hundred; in 1890, thirteen hundred and twenty-five; in 1891, eleven hundred and seventy-one; in 1892, eleven hundred and fifty-eight—an average of three publications *per diem*.

These figures have an import of their own which needs no comment. But they have also, by implication, a meaning which shows the trend of the science: they are the effect of specialization and they compel specialization. Argue as we may about the pedagogical value of specialized studies, we cannot rule out the fact that they are the main-spring of scientific progress. That steady differentiation which has given to the various empirical branches a certain independence has affected philosophy as well. Logic,

psychology, and ethics tend more and more towards autonomy, as special research widens out their respective domains. And as new workers crowd into the field, the activity of each, in order to be productive, must be restricted, and make up in depth what is apparently lost by the limitation of surface.

It does not follow, however, that the specialist in psychology or in any other science can afford to lose sight of those relations which, on a higher plane, bind all branches of knowledge to unity, or to dispense with that broader education which makes his after-building secure. But it does follow that the preparatory training must be revised so as to balance by its generality the specialization which is to come later on. How the revision shall be accomplished is a problem for pedagogics. Any scheme of education that is proposed as a solution must keep in view not only the abstract bearing of science upon science, but also the capacity of those who are educated. To train the mind without a knowledge of the mind is absurd. To force it, irrespective of its aptitudes, into a rigid mould, is dangerous. And it is equally fatal to adopt a system in which the powers of observation, of concentration, and, above all, of independent thinking, are not adequately developed. We are thus brought round to a new and more practical aspect of psychology—its application in the school-room. In whatever fashion the teacher performs his task, he is, consciously or unconsciously, applying psychological notions. Is there any reason why these should be wrong rather than right, vague and tentative when they might be precise and methodical? It cannot be said that modern psychology has, as yet, rendered to pedagogics the full share of usefulness which the relations of the two sciences would lead us to expect. But noteworthy advance in this direction has been made especially by some of our American psychologists. Further results will doubtless prove that the experimental study of mind may be turned, indirectly at least, to the profit of all the sciences, and that whatever psychology owes them may, in time, be amply repaid. In rendering this practical service, based upon exact and painstaking research, the new psychology not only helps us to know the mind but also helps the mind to know. In both respects it has progressed; in neither can it be blamed for being modern.

E. A. PACE.

CATHOLIC UNIVERSITY.