EXPERIMENTAL PSYCHOLOGY

CHAPTER I

ON THE STANDPOINT OF EXPERIMENTAL PSYCHOLOGY[1]

The Relation of Experimental to General Psychology.—Experimental psychology has sometimes been styled the 'new' or 'scientific' psychology. It has been spoken of as if it were quite distinct from, and independent of, the older or 'general' psychology, in which experiment finds no place. Now these are manifest errors. For experiment in psychology is at least as old as Aristotle. And scientific work is possible (*e.g.* in astronomy, geology, and natural history) under conditions which preclude experiment. We must regard experimental psychology as but one mode of studying psychological problems, not all of which, however, can be approached from the side of experiment. Far from being independent, experimental psychology has arisen as a refinement, of general psychology. Familiarity with the latter is essential to success in the former.

The Conditions of Experiment in Psychology.—Experiment consists in observing the play of prescribed conditions; its object is to secure accurate information. So long as the conditions are known and are controllable, an experiment can be repeated by the same or by other investigators, the original observation can be confirmed or modified, and the

[1] The student may expect to understand the contents of this chapter more thoroughly when it is re-read at a later stage of his progress.

experiment can be made to yield further information by simplification or complication of these conditions.

Experimental psychology studies the responses of individuals to prescribed conditions. Not every response, however, possesses psychological interest. Experimental psychology is concerned only with those responses which directly or indirectly throw light on the analysis and the course of consciousness.

The conditions in psychological experiment are the internal conditions of the individual (or 'subject') on the one hand, and the conditions of his environment on the other. A psychological experiment may accordingly be modified by altering either the mental attitude of the subject or the outer influences to which he is exposed.

The Response of the Subject.—The subject responds to a psychological experiment by undergoing changes in inward experience or in outward action, usually in both ways. It is clear that the former mode of response can only be studied by the subject himself; his states of consciousness, his experience throughout the experiment, can be revealed solely by his own introspection. On the other hand, his outward action, his behaviour towards the experiment, is best studied by an independent observer. For, in the first place, it is generally admitted that no man is a judge of his own actions; and, secondly, the subject's attention during a psychological experiment is, as a rule, already fully occupied in introspection. Therefore, in all but the simplest psychological investigations, the co-operation of two persons is desirable—the subject recording his inner experiences, and the experimenter recording the subject's outward behaviour.

The Subject and the Experimenter.—If the same individual is at once subject and experimenter, he must needs prescribe for himself the experimental conditions, and is thus in the position to observe and to appreciate the results obtained. He is, we may say, 'fully informed.' He knows what is about to happen, and he knows precisely what to look for. Under such conditions, auto-suggestion has full play with him; 'the wish is father to the thought.' He knows, too, whether he has

succeeded or failed in the object of his experiment, and is encouraged or depressed accordingly.

On the other hand, if an experimenter co-operates he can arrange the experimental conditions so that the subject is more or less 'uninformed,' a more complete freedom from prejudice being thus attained. Then, also, the experimenter may purposely repeat the same experiment when the subject is in different stages of foreknowledge, practice, or fatigue; or he may perform it under like conditions upon different subjects.

Introspection in Experiment.—It is frequently urged that the act of introspection cannot fail to disturb the normal course of the subject's attention. An endeavour is as often made to evade this objection by the substitution of *retrospection* for introspection; which in turn prompts the further objection that memory cannot be relied upon to give a psychologically just description of a bygone experience. But the use of the experimental method reduces, even though it does not abolish, the force of each of these objections. With increasing practice, the attention can be trained to oscillate rapidly to and fro, the subject now responding to experimental conditions, now observing the nature of his consciousness during response; just as with practice he can successfully dictate a letter and read a book, to all outward appearances simultaneously.

It may reasonably be objected that the repetition of an experiment can never bring with it an exact repetition of the subject's original mental state. Nevertheless, practice enables him to detect experiences which had previously escaped him, and generally to improve his memory for bygone states of consciousness. That is to say, practice improves his power of introspection and retrospection.

Fundamentally, of course, all introspection is retrospection, and the objection to either arises, in great part, from the mistaken notion that we can ever describe *momentary* states of consciousness. It has been truly said that "neither my experience as a whole, nor the position and relations of any part within that whole, can be given as the content of

momentary consciousness. The momentary consciousness is only one link in the series which constitutes my experience[1]."

The limits to the scope of introspection, on which stress is laid in works dealing with general psychology, are of course equally valid in the region of experimental psychology. No one can adequately perform introspection, when dominated by intense passion or by intense desire; nor can he adequately describe such experiences, when the passion or the desire has passed away. Attention to the pleasure or pain of an experience inevitably modifies that pleasure or pain. The more prominently affective or conative be a state of consciousness, the more difficult it is to study it. In such instances, especially, we may hope to advance our knowledge by observing the subject's outward action or behaviour.

The Behaviour of the Subject.—The study of the subject's behaviour always forms an important part of psychological investigation. It enables us to obtain numerical data which serve as an index of mental activity; to observe variations in the accuracy or in the mode of the response, which, aided by introspection, throw light on the nature of the conscious processes involved or reveal differences in different individuals; and to record involuntary movements, *e.g.* movements of the limbs and changes in the circulation or respiration.

Such data clearly gain in significance when they can be correlated with and confirmed by the subject's introspective record. Accordingly, it is a golden rule that introspection should never be omitted in a psychological experiment. There are, however, conditions under which it is impossible to avail ourselves of the aid of introspection, as in the investigation of unconscious processes, in experiments on animals and sometimes in experiments on children or savages, or on individuals in abnormal (*e.g.* hypnotic or pathological) conditions. In all circumstances the dangers of directly deducing the mental state of an individual from observation of his behaviour cannot be too strongly emphasised.

Psychology as a Science.—We are now in a position to realise that it is only the possibility of giving a physical

[1] G. F. Stout, *Analytical Psychology*, London, 1902, vol. I, page 44.

expression to mental states which confers on psychology the rank of a science. This physical expression is obtained in two ways,—first by the observation of the subject's outward behaviour, and secondly by the description of the subject's inner experience. About the former we need say nothing more at present; so clearly is outward behaviour a mode of physical expression. But it may at first sight seem strange to say that when the subject describes his own mental states, he is likewise giving vent to physical expression. Yet such is really the case; otherwise a science of psychology would be impossible. For from the psychological standpoint, as we have seen, no one can observe the mental states of another. Mental states are their subject's private property,—a contrast to the apparently common property of objects of the physical world. As soon, however, as a subject takes the trouble to record his mental states, he expresses them physically. He speaks or he writes,—that is to say, he employs physical movements which are patent to and significant for his fellow-men.

It is the object of experimental psychology, as of all other experimental sciences, to describe the complex in terms of the simple. Just as physics attempts to express objective experience, so experimental psychology attempts to express subjective experience, as a series of equations, reducing the complex on the one side of the equation to its elementary components on the other side.

From one aspect a certain mixture of hydrogen and oxygen is identical with an equal mass of water. From the same standpoint the binocular presentation of two stereoscopic views may be considered as identical with the single view in relief which it yields; or the simultaneous presentation of a tone with its overtones may be considered as identical with the peculiar timbre which results. But neither in chemistry nor in psychology are we satisfied with equations that have a merely existential import. Although the hydrogen and oxygen remain undestroyed during their transformation into water, we cannot overlook the fact that important alterations have taken place in their relations to one another,—that

they have fused to form a chemical compound instead of being, as previously, a mechanical mixture. So, too, in our psychological examples, we cannot overlook the fact that the several tonal sensations have fused to create a totally new experience of timbre, or that the two visual perceptions have fused to create a totally new experience of relief.

Both chemistry and psychology must recognise the inexplicable nature of this fusion. The former may attempt to reduce the characteristic properties of water to terms of altered molecular composition and movement. Such so-called explanation, however, consists merely in describing the phenomena in other language, in translating them into other modes of experience. The conditions or equivalents of fusion are not its explanation; its *esse* is its *percipi*.

But this apparent similarity of physical to chemical fusion breaks down on closer inspection. In the first place, neither the sensations nor the results of the fusion could ever be experienced, were it not that they go to form part of, and to fuse with, the subject whose experience they are. In the second place, the very experience to which they, each or together, give rise, is determined by the past experiences and by the present condition of the subject. The experimental analysis and synthesis of the subject's experiences must therefore be supplemented by the study of the personality of the subject,—a field in which pathological and hypnotic investigations promise a rich harvest, but into which experimental psychology has only of late begun to inquire.

Lastly, let us remember that we are quite unconscious of any fusion between two (or more) simultaneous sensations or perceptions, in the examples above chosen. To be convinced of this, we have only to look into a stereoscope or to listen to the tone of a musical instrument. The complex, *i.e.* the relief or the timbre, is all that we are aware of. In our ignorance we deem it simple; the different experiences of the two eyes, or the presence and inter-relation of overtones, are only brought to our notice by special methods. Thus, without pursuing the subject further, we see that in psychology it is untrue to say that first we have sensation H_2 and its

companion sensation O, which then, by the touch of a fairy wand, suddenly become transformed into a new complex H_2O. All we can truly say is that stimuli, which separately give rise to unlike experiences, may, when acting together, give rise to a totally different complex, without evoking (or, to speak more generally, without necessarily evoking) the unlike experiences themselves.

Psychological Abstraction.—We shall begin the study of experimental psychology by considering the most elementary mental units into which we can analyse the presentations of external objects,—sensations. It might be thought that any chance stimulation of the sensory end organs of our body must inevitably yield a sensation. But, as we have just pointed out, under no circumstances are our sensory experiences isolated independent parts of our mental system. They form with one another and with the rest of our mental system complexes which have been evolved for the express purpose of securing adjustment to external surroundings.

In our endeavour to obtain sensations in a state of requisite purity, we have often to adopt special experimental and introspective measures, stripping presentations, so far as possible, of all those characters which ordinarily make them vehicles of meaning. In the course of such processes of abstraction, we shall at times discover and study sensations, of whose nature we were previously scarcely aware, either owing to their invariable coexistence with other mental states, or owing to their relative unimportance as a means of interpreting, or of consciously adjusting ourselves to, the outer world.

It is commonly supposed that in the developing individual these simple mental states form the primary substratum from which his more complex states are subsequently developed. An exactly opposite view is nearer the truth. The clearer, simpler states should be regarded broadly as secondary to vaguer, more complex states from which they are derived through the analytic, differentiating activity of the growing mind.

Experimental in relation to Physiological Psychology.—In the study of sensations, the experimental psychologist who

investigates mental states proceeds hand in hand with the physiologist, the investigator of the functions of living matter. Here experimental psychology and physiological psychology are inseparable for a thorough treatment of the subject, protoplasmic activity throwing light on the ultimate analysis of sensation, and sensation throwing light on the significance of protoplasmic activity, as our knowledge of each progresses.

In other regions of psychological investigation, the connexion between experimental and physiological psychology is not so close. For example, by far the most important discoveries made by experimental psychology in regard to memory, comparison, and mental work are at present quite devoid of physiological basis. It is important early to recognise how independent the truths of experimental psychology are of the determination of the corresponding neural processes by physiological psychology.

Some psychologists, indeed, refuse to accept psycho-physical parallelism as a principle applicable to all mental processes. But provided that a proper meaning be attached to the term 'psycho-physical,' a thorough-going parallelism probably affords the best working hypothesis for experimental psychology.

'Physical' phenomena are the result of purely mechanical conditions. If those conditions are known, the result can be predicted. It is, however, only in comparatively simple, and usually in artificially established, conditions that the physiologist can accurately predict what reaction will occur with a given stimulus. The living body is characterised by unknown 'vital' activities as well as by known 'mechanical' activities. There are many who believe that the two differ from one another rather in degree and complexity than in kind; for the history of physiology shows how activities which had been considered as vital by one generation, have been resolved into mechanical activities by another generation, of physiologists. Yet the fact remains,—and it applies especially to the nervous system of the intact animal,—the conditions are so complex and obscure that there are many physiological results which it is impossible to predict.

Similarly in psychology some experiences occur in a purely, or almost purely, mechanical manner; the conditions are so well known that a definite result may with fair confidence be predicted. But, as in physiology, 'mechanism' has the strictest limitations. Indeed the troubles which beset the physiologist and the psychologist are essentially identical. Vital activity presents the same difficulties as mental activity; from a broad enough standpoint the former may be said to include the latter. There is thus a true 'psycho-physiological' correlation, and it is in this sense that the term 'psycho-physical' parallelism must be understood.

The Aims of Experimental Psychology.—The difficulty of prediction, to which attention has just been drawn, is often used to support the argument that a science of experimental psychology is impossible. It is urged that a given individual varies at different times and that individuals differ among themselves so greatly, as to preclude the possibility of generalisation. But experimental psychology is not engaged merely with general problems, *e.g.* studying thresholds, determining the scope of attention, or fixing the limits of memory. It has also, as we shall see later, to determine how such 'properties' of the mind are affected in any given individual by different conditions, and how far and for what reason they are different in different individuals. The difficulties of prediction, therefore, enhance rather than detract from the scientific interest of the subject. Similar difficulties, of lower or higher order, thwart our prediction of the weather or of the course of evolution: where also the conditions are too complex and too changeable for us to foretell with certainty the order of events. It is the aim of all science, and hence the aim of experimental psychology, to analyse, so far as possible, the conditions which may be at work, and to determine the results which must follow, provided that those conditions are present.

CHAPTER II

ON CUTANEOUS AND VISCERAL SENSATIONS

THE exploration of the skin by punctate stimuli (exp. 33) shows that its sensibility to touch, pain, cold, and heat is not distributed uniformly over the surface. The skin contains certain 'spots' which are particularly sensitive to the lightest touch, others which are sensitive to pain, others again which are sensitive to cold, and others to heat.

Touch Spots.—On hairy parts of the skin, a touch spot is to be found over the site of each hair root or follicle (exp. 33 (*a*)). A few touch spots are also met with between the hairs; they abound on the hairless surface of the palm and sole. A rich plexus of nerve fibres surrounds each hair follicle, the latter being the probable seat of the tactile end organ. It has been suggested that, on hairless surfaces, Meissner's corpuscles are the end organs corresponding to those of the hair follicles. At the tip of the finger, touch spots are so abundant as to be inseparable; and here the number of Meissner's corpuscles is correspondingly large. Touch spots are absent in certain situations, *e.g.*, according to certain observers, on the cornea. Touch spots react to stimuli, which are far too weak to excite nerve fibres directly. They react not only to pressure, but also to traction of the skin, *i.e.* to pull as well as to push; the sensation being the same for either form of stimulus. The skin is sensitive to diffuse light touch (*e.g.* to the touch of cotton wool) where punctate exploration fails to show the existence of touch spots.

Cold Spots.—They are for the most part irregularly grouped, sometimes forming chains or clusters, but also