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SUCCESSES AND FAILURES OF EXPERIMENTAL PSYCHOLOGY[1]

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IT is customary to claim for psychology that, while it has a long history as a branch of philosophy, it can be excused for a considerable degree of immaturity because of its youth as a branch of experimental science. As the decades go by this excuse becomes less and less convincing. There are several very active and successful sciences, as physical chemistry and bacteriology, which are really younger than experimental psychology. If these sciences have made more rapid progress than psychology, the reason may be that they are working with phenomena that lie further from everyday experience, so that their discoveries are more striking. Other reasons can be suggested. Possibly psychology has undertaken a harder job, a more complicated problem to unravel—or possibly psychologists have not been making good use of their time. At any rate psychology should be able by now to point to substantial achievements won by use of experimental methods, along probably with a number of failures which may be quite instructive in themselves. It would be too much to attempt here and now to answer the question, how much has been achieved by experimental psychology in the half century or more of its existence. We can only touch a few high (and low) spots in the hope of conveying some idea of the progress of psychology as it appears to those who are actively interested in pushing it forward.

[1] Annual Sigma Xi address, Indiana University, March 13, 1941.

Beginnings of Experimental Psychology

No precise date can be assigned for the beginnings of our science. The year 1860 is as suitable as any. Before that time, and during all the earlier part of the nineteenth century, physicists and physiologists had been occasionally making experiments which could properly be included in psychology. There were many experiments on the senses and sense perception. Just about 1860, Helmholtz and Fechner organized these earlier results and suggested laboratory methods for the further study of such problems. Almost simultaneously Darwin gave a start toward the scientific interest in animal behavior and child development, matters which have become very important to the psychologist. Darwin was soon followed by Francis Galton, who ranks as one of our pioneers for his work on individual differences, tests and correlations. In Germany, Helmholtz and Fechner were followed by Wundt and other leaders who established psychological laboratories in some of the universities, beginning about 1880. These laboratories were adjuncts of the departments of philosophy, and their first directors were professors of philosophy. This was generally true as the new movement spread to other countries, though in a few universities the psychological laboratory was at first attached to the laboratory of physiology. In general the physiologists were fully occupied with other developments in their rapidly growing science.

The American universities were prompt to adopt the new psychology. In the eighties and nineties a large number of laboratories were established from the Atlantic to the Pacific. The Indiana laboratory was one of the first. Except for scattered studies the birth of experimental psychology was nearer 1890 than 1860. Just about now many of our laboratories are celebrating their fiftieth anniversaries, and the American Psychological Association, organized by the young protagonists of the new movement, is to have its jubilee in 1942.

The motive animating these pioneers was partly the desire to see psychology emulate the older sciences and partly a sense of the futility of endless discussion unsupported by definite data. As Wundt said in 1862, psychology was properly a natural science but had made little progress since Aristotle. Its stagnation was due to its lack of scientific methods and to the metaphysical problems in which it was enmeshed. If psychology would turn its attention to questions answerable by natural science methods it would be on the road to progress.

We can not complain of the attitude of the philosophers. Without some support from them, those laboratories could not have appeared in such rapid succession. The philosophers were indeed rather sceptical as to the scope of experimental psychology. It could perhaps shed some useful light on minor questions but could scarcely be expected to solve the great problems of body and mind and the theory of knowledge. Probably they were right, and probably Wundt was right as well in holding that psychology should turn its attention to new problems. Psychology had to explore and find its own distinctive problems as it became acquainted with its proper field.

Scepticism was not confined to the philosophers. Many natural scientists believed the field of mental phenomena and operations much too intangible and elusive for genuine experimentation. "How can you possibly experiment on the mind?" was a common query. "You can not control your variables." Some work could be done on the senses, but such work was more appropriate for physiology than for a science of the soul or mind. True enough, anything like a mystical or transcendental conception of the mind rules out or scares away the experimental psychologist. But he has found other ways of conceiving the mental activities of the individual. Though there is some real difficulty in controlling the variables the project is not so hopeless as it seemed at first. The attempt must be made, anyway, unless we are willing to resign ourselves to continued ignorance.

The psychologists went to work in their new laboratories. There was much work still to do on the senses, and here the physiologists and physicists have continued their efforts, the psychologists however contributing a respectable share toward the progress that has been made. There have been failures as well as successes, but we will pass on to other problems that are perhaps more characteristic of psychology.

Psychophysics

Fechner, as much as any one, is entitled to be called the father, or grandfather, of experimental psychology. Primarily a physicist, he was also a philosopher of a rather mystical turn who believed in the existence of two worlds, the physical and the psychical. What he called psychophysics was an attempt to demonstrate definite relations between the two worlds. When light stimulates the eye or sound the ear the stimulus belongs in the physical world, the sensation in the psychical world. Living at a time when the conservation of energy was a new discovery and when the transformation of energy from one physical form to another was being investigated, Fechner asked whether some equation could not be worked out between the energy of the stimulus and the intensity of the sensation. As the stimulus increases the sensation increases but seemingly not so fast. Weber's law, which Fechner named after its discoverer and further tested out and verified to a reasonable extent, was interpreted by Fechner as showing that the sensation increases as the logarithm of the stimulus intensity. So he had a psychophysical law. The experiment was a success in his own view.

But Fechner did not succeed in convincing the scientific world that his law was truly psychophysical. It seemed more likely to be purely physiological. For proving his point to his contemporaries or successors, his experiment was a distinct failure. Nevertheless as an empirical law, subject indeed to certain limitations, the Weber-Fechner finding has proved of considerable importance, both in science and in engineering. And the psychologists are deeply grateful to Fechner for the skill and care with which he worked out experimental methods for testing his law. These methods have proved to be invaluable in a variety of problems.

The Reaction Time Experiment

One of the oldest psychological experiments can be seen in operation on the athletic field. The contestants in a foot race line up, are told to be ready, and then get the signal to go. If the time from this signal to the first forward movement of the runner were measured, it would differ from one individual to another and probably average about one fifth of a second. Take this performance into the laboratory and simplify the conditions, substituting a finger movement for the forward spring of the whole body, and you have the reaction time experiment. What scientific use can be made of so simple a thing?

The experiment was first used by Helmholtz in 1850 in the hope that it would furnish a measure of the speed of conduction in the sensory nerves of man. He had succeeded in measuring the speed in the motor nerves of an animal. He could tell when the nerve current reached a muscle by the resulting muscle twitch, but he had no way of telling exactly when a sensory nerve current reached the brain. The best he could do was to instruct his human subjects to react with the hand as soon as they felt a weak electric shock applied to some part of the skin. The farther this part of the skin was from the brain, the longer the sensory nerve conducting to the brain and the more time should be required for the whole reaction. The experiment was only moderately successful, there was so much variation in the reaction time, due doubtless to variation in the brain process involved. At least, the variability of the brain action in so simple a performance is a fact worth knowing.

Another use was soon suggested for this experiment. Complicate the performance and see how much additional time is required. Instead of a single, uniform stimulus to which the subject always makes the same reaction, let him understand that there are to be two stimuli, a red and a green light, and that when the red appears he is to move his right hand; when the green, his left hand. It takes him about one tenth of a second longer. The brain has an additional task to perform—or two additional tasks, that of distinguishing between red and green, and that of choosing the correct hand for the reaction. Therefore, it was inferred, the extra one tenth of a second is the time required by the brain for the acts of discrimination and choice.

The hope of certain experimenters, back in the sixties, seventies and eighties, was by use of this experiment to determine the time required for each elementary mental operation, like discrimination, choice, recognition, association. The idea was to insert extra elements of performance into the reaction and to see how much extra time was required for each element. The plan broke down because the subject did not passively wait for the stimulus and then go through the supposed sequence of elementary acts. Instead, he was active before the stimulus arrived, preparing himself for the total act he had to perform. When the act was completely defined in advance, as in the simple reaction, the subject's preparation was very definite, but when two possibilities were in prospect, he could not prepare himself so completely. His reaction was slower because his preparation was less complete, and the extra time required was not merely the time of an inserted elementary act.

Obviously, the reaction time experiment was a failure, so far as the original purposes of the experimenters were concerned. Yet the results were instructive in a number of ways. They showed the importance of what we now call "preparatory set," the state of readiness for an anticipated reaction. And reaction time has proved to be a useful tool in investigating various problems. When Cattell, working in Wundt's laboratory about 1885, found by the reaction time method that familiar short words were perceived and read as quickly as single letters, the result threw much light on the psychology of perception and on the best method of teaching a child to read.

Experiments on Learning, Memory and Motor Skill

The early psychological experimenters saw no way of attacking the "higher mental processes," but in the eighties Galton in England and Ebbinghaus in Germany showed that memory and related processes could be brought into the laboratory. It was Ebbinghaus who invented nonsense syllables for use in memory experiments. He presented a series of such totally unrelated items for the learner to connect and memorize. Entirely new connections had to be established, as would not be the case with a sequence of familiar words. By this device Ebbinghaus succeeded to a certain extent in controlling an otherwise disturbing variable. He obtained a characteristic "curve of forgetting," showing that the loss of barely learned material is rapid at first and slower as time goes on. He varied the conditions of learning and demonstrated the operation of a number of significant factors. His work put new life into the laboratory and started a line of investigation which continues fruitfully down to the present, with many ramifications. On the whole his experiment was a decided success.

On one respect, however, the original experiment of Ebbinghaus must be called a failure. He apparently assumed the learning process to consist in an automatic establishment of associations between the nonsense syllables. The learner was giving careful attention to the material, to be sure, but the connections were supposed to be formed by a simple mechanical process and strengthened by a mere repetition of this process. Later experimenters, by varying the method and obtaining more complete data, have found that the learning process is by no means simple and automatic. The learner is intensely active, grouping the syllables, noting their positions and their similarities and differences, and often reading some meaning into the syllables. The first experiments had left a false impression of the nature of the learning process. Objection has also been raised to the use of nonsense syllables because of their artificiality, but this objection is not very serious because in the first place the method is easily extended so as to employ meaningful material, and in the second place, no matter how artificial the material, the learner is not made artificial, and the various ways in which he attacks the artificial task bring out very clearly the characteristics of an intelligent learner.

An important next step in the experimental psychology of learning was taken here at Indiana University in the nineties, when Bryan and Harter conducted their pioneer experiments on the acquisition of skill. The telegrapher's skill was the particular topic of their investigation, which was followed up in the next decade by Book's study of the process of learning to use the typewriter. These experiments can be counted among the eminently successful ones and they inaugurated another long series of investigations, by many experimenters in various places, dealing with the problem of how motor skill is acquired.

In learning to typewrite, for example, one must first become familiar with the keyboard so as to strike each letter promptly and accurately as it is reached in spelling out a word. When the learner can do this he assumes he has mastered the art, in principle, and needs only to increase his speed. As he continues he is surprised to find himself performing in unexpected ways. He catches himself in the act of writing a familiar word without spelling it out. His fingers go through the necessary sequence of movements as an integrated pattern, no longer as a series of discrete acts. These spatial-motor patterns are called "higher units." The telegrapher also, after considerable practice, hears a whole sequence of clicks from the sounder as an auditory pattern. He hears word units rather than letter units or single clicks. Higher units are built up in any skilled performance. Some of the best examples are found in ordinary speech. To speak a word demands a sequence of speech movements—one for *c*, one for *a* and one for *t*, in pronounced the word *cat*—and the little child learns by degrees to build up this unit. It becomes so much a unit that later he can scarcely break it up into its parts. He hears it as a unit, too.

Within the general field of experiments on learning the next development was the study of problem-solving and learning in animals. Here again the work began in the nineties. The original interest was in the evolution of animal intelligence, but a more definitely psychological problem soon came into view. The learning process seemed to be fundamentally the same in man and the higher animals, and the fundamentals were more clearly revealed in the simpler behavior of animals than in man with his intellectual and linguistic devices for rapid learning. On the whole these animal experiments must be counted among the successes of psychology, though it would not be difficult to find particular studies that have started with false assumptions and led temporarily to false conclusions.

About 1900 a new type of experiment on learning was originated in Russia by the physiologist, Pavlov. This was the conditioned reflex experiment. A dog's saliva will start to flow, not only when food is placed in his mouth (a natural reflex) but also when a bell is rung, provided the bell has repeatedly been rung just before he receives his food in a familiar laboratory situation. Evidently this conditioned reflex is a learned response. It was so regarded by Pavlov, but he was not particularly interested in it from this angle. To him it was an indicator of the physiological processes of excitation and inhibition going on in the brain. He insisted that his experiment was definitely physiological and not in the least psychological. Nevertheless the psychologists appropriated the experiment as a new lead in the study of learning. It might go to the bottom of things and provide an explanation of all forms of learning. They have tried the experiment on human as well as animal subjects and have varied it in many ways. The more recent experimenters find, however, that conditioning is by no means so simple a process as was first supposed. It is not a mere attachment of an old response to a new stimulus but is, rather, the building up of a new pattern of response adjusted to a particular combination of stimuli. It depends on good adjustment to the total situation. And the process of becoming conditioned sometimes involves trial and error and even insight. In short, though the external conditions are greatly simplified as compared with ordinary life, the subject himself is not simplified but is free to utilize any of his devices for meeting a novel situation.

THINKING

After a start had been made in experiments on learning and memory, the next question was whether any feasible experiment could be contrived for studying the thought processes. Some information on problem solution by men and animals could be obtained from the learning experiments, since the subject's first trial in a new task calls for the solution of a novel problem. What is usually called the "thought experiment" dates from early in the present century. The subject is assigned a problem to solve and reports what he can of his procedure. Time is taken and other objective records may be made of his behavior. This rather rudimentary experiment has yielded some interesting results but can not be called an outstanding success. At first interest was centered on the question, what mental images were used in thinking. Some subjects reported visual pictures "before the mind's eye," other subjects reported mostly inner speech, others reported that when a new idea was just dawning on them it came neither in words nor in pictures but just as a bit of meaning, an "imageless thought." The results were rather intangible and the whole enterprise languished after a few years of great activity. One definite finding was that the "set" for the task, which had been found important in reaction time experiments, was a potent factor also in thinking and intellectual work. The thinker adjusts himself to his task and so steers his thoughts more or less definitely in the right direction.

A little later the behaviorists suggested that thought was probably a motor activity. It might consist largely of slight movements of the speech organs. At first the child thinks aloud, we may suppose, and later cuts down the amplitude of his speech movements while still thinking with his mouth and larynx, though perhaps also with his hands and feet. This theory challenged the experimentalist to detect any slight speech movements that might occur during silent thought. Hopefully he applied recording instruments to the tongue and to the neck over the larynx, and he obtained evidence of some muscular activity during thought but nothing that seemed characteristic of different thoughts. His instrumentation in this first period was crude and lacking in sensitivity. Nowadays amplified muscle potentials afford a much better index of slight motor activity, and this method does show some muscular activity in the arm, for example, when the subject thinks of lifting a weight. This line of investigation is still in its early stages and we can not predict how much it may show regarding the dynamics of the thought process.

MOTIVES AND EMOTIONS

An important problem under the head of emotion can be put as follows: What is the state of the organism in fear, rage, joy and the various emotions? We have a partial answer from physiological and psychological experiments. As to the motivation of behavior we have some rather fundamental findings from the animal laboratory. This whole line of work is difficult and has scarcely made satisfactory progress.

Mental abnormalities, the neuroses and psychoses, are due to emotional disturbance and conflict of motives more than to intellectual disorder. So the psychiatrists believe, but they say they can find little of value in the experiments of psychologists on motives and emotions. Freud in particular denied that he could get anything at all from the experimental psychologist, but he may not have tried very hard. He was himself in a sense an experimenter in applied psychology. His experiments were clinical, intended to discover what theories would work well in the treatment of neurotic patients. Early in his career he was momentarily disturbed to find that his female patients were likely to fall violently in love with him during the long course of a psychoanalysis. His hypothesis was that these patients were not in love with him as an individual, exactly, but rather as a father substitute, and he inferred that the emotional attachment would flatten out if he maintained a professional attitude and allowed the patients to use him as a father substitute while working out their emotional problems. The hypothesis seemed to work very well in many cases, though it must be admitted that the success of the treatment does not demonstrate the truth of Freud's conceptions, since somewhat different hypotheses would predict the same result.

Freud put out an enormous number of hypotheses, or assertions, applicable not to clinical practice alone but to everyday life, and it is strange that more of them have not been tried out by psychologists. Recently certain experiments on conflict and frustration, more or less definitely suggested by Freud's writings, have found their way into the laboratory with interesting and promising results. Undoubtedly many of Freud's dicta would not stand up in an experiment, at least in their original form, though they might be suggestive.

Pavlov's "experimental neurosis," an outgrowth of his conditioned reflex experiment, appears at present to be a promising lead for the laboratory man, perhaps more promising than most of the Freudian hypotheses. We can not expect a dog's or a rat's neurosis to be identical with that of a human being, and we can not hope to carry over the results of the animal laboratory directly into the psychiatric clinic. But something has been gained when we know definite procedures for creating a condition of nervous instability in an animal, especially if we can also discover how to bring him out of that condition.

CHILD DEVELOPMENT

The question, how an abnormal condition arises, is part of the broader problem of tracing the development of the individual and discovering the factors that promote, impede or modify development. This is a problem now being fruitfully attacked by many psychologists by the method of following the child through from birth to maturity. Tests and laboratory methods are used to give an exact knowledge of the course of development and to reveal differences between children in relation to their parentage and environment. But a developmental experiment in the full sense is not easily carried out with human subjects. The psychologist must not introduce experimental factors which might result in mental deficiency or abnormality. He could introduce conditions such as would probably improve the child's development, but he seldom has sufficient control over the child and family to insure a clean-cut result. Attempts are being made, however, and no doubt we can expect increasing success as the work continues.

SURVEY EXPERIMENTS AND TESTS OF HYPOTHESES

The complaint is often heard, as we have already found, that laboratory conditions are too much unlike those of everyday life to throw any light on life and behavior. The complaint is only partially justified. We must distinguish two types of experiment. There is the exploratory type which surveys a field of phenomena in the hope of turning up something that may be of significance. The keen observer, in well-known historic instances, has obtained leads from such surveys that have carried him along to important discoveries. It is decidedly worth while for the psychologist to discover how the individual acts in a variety of conditions, including certainly the conditions of everyday life.

The other type of experiment is pointed up to check some definite hypothesis; and here there is no need to keep the conditions lifelike if only they are such as will provide a clean test of the hypothesis. The hypothesis itself should have some bearing on everyday life, but the question of its truth or falsity is sometimes best put to the test by introducing conditions that are artificial or at least unusual. This is true of some of the best experiments in the older sciences. What is the use, some one might ask, of experimenting to see how a bullet and a feather fall in a vacuum, since in nature they never do fall in a vacuum? The answer is that the experiment provides a definite check on a proposed law of falling bodies. In applying the results to the fall of bodies in the air a correction must of course be made for the resistance of the air, and in the same way a correction will often be necessary when the findings of the psychological laboratory are applied in the clinic, the schoolroom or the athletic field. Just as the engineer must make experiments of his own to determine how the general laws of physics will work out in a complex system like an airplane moving at high speed, so the applied psychologist needs to take over from the experimentalist not his results only but his attitude and general method.

One who has lived through a large share of the history of experimental psychology is sometimes asked whether the present generation of experimenters, so greatly exceeding in number the small band of the old pioneers, measures up to their level in quality of work, and whether any substantial body of scientific knowledge has been built by the assiduous labor of half a century and more. My own answer to both these questions is in the affirmative. My impression of the younger men is that they stand comparison very well with the older group. And any one who takes the trouble to compare their background with that provided by the older psychology will soon realize that there has been a great advance. The results of experimental psychology are not as yet well systematized, and there are large gaps in our knowledge, but the present state of the science is a challenge to the younger men rather than any ground for discouragement.

OBITUARY

VICTOR JOLLOS

1887–1941

DR. VICTOR JOLLOS, a leading student of heredity and mutation, died suddenly at Madison, Wisconsin, July 5, 1941, following a short period of ill health. He was born in Odessa, Russia, on August 12, 1887, the son of Gregor Jollos and Rosa Jurowsky Jollos.

Dr. Jollos spent his entire youth in Germany, where his parents had established residence before his birth.