



Philosophy of Science Association

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Source: *Philosophy of Science*, Vol. 3, No. 1 (Jan., 1936), pp. 90-103

Published by: The University of Chicago Press on behalf of the Philosophy of Science Association

Stable URL: <http://www.jstor.org/stable/184758>

Accessed: 14/06/2010 14:11

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Psychology: The Propaedeutic Science

BY

S. S. STEVENS

PREVIOUS claims that psychology is propaedeutic to the other sciences have been met with enthusiastic indifference. Contributing to this indifference has been the fact that psychology, a young and unproved discipline which habitually borrowed the methods of the older sciences, has too frequently revised its notion as to its own nature and subject-matter. More important, however, has been the faith of the physical sciences in the absolute character of their own basic concepts: in the reality of Absolute Space and Absolute Time and in the universality of deterministic principles, for, as long as physics presumed to deal with entities which are what they are regardless of the nature of man, nothing other than these entities appeared to demand prior consideration. The problem of the nature of the observer in the physical experiment became important to physics only as a consequence of the recent 'subjective' revolution. It is this revolution which has revitalized the problem of the propaedeutic science and has accentuated the distinction which we must make between the behavioral phenomenon of individuals creating formal arrays of words or symbols which are without operational meaning and the discriminatory responses, or operations, by which the empirical meaning of such arrays is determined.

ANTECEDENTS

Wilhelm Wundt fathered the view that the subject-matter of psychology is immediate experience. The subject-matter of physics, then, must be mediate experience since its data and concepts are inferentially derived. But since immediate experience is antecedent to mediate experience it would appear that psychology must be antecedent or propaedeutic to physics. All very well, except for the fact that the historical development of the sciences seems to deny any such relationship. Indeed the historical perspective renders somewhat ridiculous the picture of a German professor implying late in the nineteenth century that his newly founded science investigates the phenomena which determine what physics can or cannot be.

Avenarius, and later Titchener, appeared to relieve the embarrassment of Wundt's position by distinguishing between psychology and physics on the basis of their points of view. Psychology and physics both treat experience, but psychology regards experience as dependent upon the individual while physics regards it as independent. We might have contended ourselves with this dictum, except for the fact that the experience in question was not adequately defined. If we are to understand by experience the sort of thing spoken of as immediate experience, we find ourselves in the vertiginous position of trying to reconcile the notion that out of our experience comes the concept of the brain as a physical entity and at the same time out of the functioning of the brain come our experiences.¹

At this point Stumpf proposed to rescue us by ordaining a third science, phenomenology, which has as its subject-matter the phenomenal data of experience and which is therefore a *Vorwissen-schaft*, propaedeutic to both psychology and physics. This treatment, however, was open to all the objections raised against immediate experience, plus the complaint that a workable operational definition of the subject-matter of phenomenology has never been formulated.

¹ Cf. discussion by E. G. Boring, *The Physical Dimensions of Consciousness*, 1933, Chap. 1.

In brief, then, we find that many of these claims of psychologists, regarding the systematic status of their science, have not been taken seriously, chiefly because:

1. The idea that psychology is the propaedeutic science was in apparent conflict with the obvious truth of history.
2. The nature of physical science itself was not well understood.
3. Satisfactory definition and understanding of the nature of psychology and the meaning of the term experience were wanting.

We might profitably drop the matter at this point and relegate all future discussions of it to the historical texts were it not for the fact that important changes have overtaken to the physical and the psychological sciences since Wundt first distinguished between them. Psychology has found itself, and physics has refound itself, in ways which coordinate their methodologies and clarify their relationship.

Before going on, however, we should accord a word of dismissal to the 'historical' objection to the propaedeutic status of psychology, for the fact that physics is chronologically psychology's senior is irrelevant. Euclid's geometry preceded the development of topology by more than two milleniums, but topology is the more basic discipline. In fact the story of almost every science shows that only after a super-structure has been erected and embellished do men inquire into the nature of the foundation stones. Such in particular has been the case in physics.

THE REVOLUTION TO RELATIVITY

Newton likened himself to a child playing on the seashore while a vast ocean of truth lay undiscovered before him. Following Newton men bent their efforts toward exploration of Newton's ocean, believing as Newton did that Truth, eternal and absolute, lay as islands waiting to be come upon. The Laws of Nature were things to be discovered, rather than invented, and concerned a universe in which events occurred at certain places in Absolute Space and at certain instants in Absolute Time. A body at absolute rest remained so unless acted upon by a force, having an absolute magnitude, which then became the cause of its motion. There was no change of motion without cause, and the firm faith

was that knowing all antecedent conditions one could predict all subsequent events. In a word, the naïve realism of the Newtonian view left the experimenter and the problem of his nature and limitations quite out of the picture.

However, when it became a question of measuring Absolute Time in order to discover whether two events were simultaneous, Einstein discovered that he was at the mercy of his clocks, of the speed of light, and also of the nature of the observer. Likewise, when Michelson and Morely set out to determine the absolute motion of the earth, they discovered themselves limited by the measuring rods which they were forced to use, and these rods in turn were suspected of changing length as they moved. What, then, is the significance of the elusive nature of the Absolute? The answer is given in the notion of relativity.

Nowadays we concede that the purpose of science is to invent workable descriptions of the universe. Workable by whom? By us. We invent logical systems such as language and mathematics whose terms are used to denote discriminable aspects of nature and with these systems we formulate descriptions of the world as we see it and according to our convenience. We work in this fashion because there is no other way for us to work. All of our measurements are relative, dependent in the last analysis upon the nature of the operations which an observer is able to perform. Further we have to concede that the process of observation is simply an interaction between the system under observation and the observer. Consequently the presence of the observer has a definite effect upon the system and, as Heisenberg has shown, may land us in a region of indeterminacy if we try to push our precision too far.

Finally, it must be laid down that when we have formulated a description by way of experimenting and observing, the meanings of our words can never transcend the operations which went into their determination; or as P. W. Bridgman has shown, a word has meaning only if and as it stands for certain concrete operations which can be performed by the normal human being.

The overthrow of scientific Absolutism we might, for obvious reasons, call the 'subjective revolution,' but, since we should

mean by such a phrase nothing other than that the relativity of the system to the observer of the system has come at last to be recognized, we can afford to dispense with a dramatic slogan. At any rate, it has now become clear that the nature of physics is conditioned in part upon the nature of the human experimenter. Furthermore, since it is the business of psychology to investigate the characteristics of the observer, we now have valid reason to propose psychology as the propaedeutic science.

Psychology studies the nature of the organism which determines in part the nature of science. But, it will be objected, this is equivalent to saying that psychology studies the organism which determines the nature of psychology—an obvious circle. The proper answer is that the statement is circular, but none the less true. The statement is circular, because, whether we like it or not, we are dealing with a universe of continuities with no ends to grasp. Nevertheless we must start somewhere, so we plunge *in medias res*, and, although we then face the problem of an infinite regress, we try to understand rather than to worry about it. The paradox of a science, which investigates the peculiarities of the observer which determines in turn the peculiarities of the science, is readily resolved when we examine more closely the nature of psychology.

THE FUNDAMENTALS OF PSYCHOLOGY

Operational² psychology, like operational physics, acknowledges the relativity of all things and proceeds forthwith to dispense with all concepts of absolute entities, forces or states and other metaphysical notions for which there exist no defining operations. A word or statement means something in psychology, as in physics, only if the criteria of its applicability or truth consist of concrete operations which can be performed. These operations may be of various orders of complexity, ranging all the way from intricate experimental procedures to the simple operation of noting the presence or absence of a thing, i.e., making an elementary discrimination. Complex operations are always reducible to more

²S. S. Stevens, The operational basis of psychology, *Amer. J. Psychol.*, 47, 323-330 (1935).

simple discriminatory acts, and all 'explanations' consist of detailing a complex set of operations in terms of simpler ones—simpler, that is to say, to the listener. The elementary discriminatory reaction on the part of human beings, then, is the fundamental operation of all science; and by discrimination is meant the concrete, 'physical' reactions of the organism to either internal or external environmental conditions.

In thus placing discrimination at the basis of all science we allow it to usurp the position formerly enjoyed by 'experience' or the 'immediately given.' Does this substitution mean that experience and elementary reactions are equivalent? It does, precisely. Any attempt to define the term experience operationally³ or point out what, concretely, is meant by the philosopher's 'given' discloses at once that the discriminatory reaction is the only objective, verifiable thing denoted. Scientific psychology is operational and as such can have nothing to do with any private or inner experience for the simple reason that an operation for penetrating privacy is self-contradictory. Therefore, we need no longer think of immediate experience as the subject-matter of psychology and the basis of physics; instead we may say that the differential reaction makes physics possible and it is the business of psychology to investigate the nature of such reactions.

Now in respect of the problem of the experimenter, we must note that it is his business to make observations (or discriminatory reactions) and report them in words or symbols whose operational basis is as self-evident as possible. As a psychologist he observes the reactions of another human being and what is even more interesting, he may himself be observed by another experimenter who may in turn be observed, so that we pass again into a potentially infinite regress. As we have already seen, we must disrupt such a regress by stopping it arbitrarily at some point. In other words, in admitting any item to the body of scientific knowledge, we assume at some stage an independent experimenter whose qualifications to observe and record data are not in question. Someone, B, of course, may challenge a particular experimenter,

³ S. S. Stevens, The operational definition of psychological concepts, *Psychol. Rev.* 42, 517-526 (1935).

A, and proceed to prove him in error. In this case we have pushed back a stage further along the regress; but, if we are to stop there, we again have accepted experimenter B as competent without question. And so on.

Since the psychologist is in the peculiar plight of being able to note his own reactions (we used to say: "observe his own consciousness"), operational psychology has to be careful to distinguish between the function of experimenter and subject. In the rôle of experimenter the psychologist can observe the behavior of both himself and his friends, but it is crucial that he treat his own reactions (introspections, key-pressings, etc.) exactly as he treats the reactions of others. In other words, the psychologist deals exclusively with the "psychology of the other one," even though looking at himself, and, if we choose to accept his reports about or as his own reactions, we are accepting his word as a competent experimenter regarding a concrete phenomenon he has observed. A steadfastly objective outlook of this sort avoids the dangers of the slough of subjectivity and makes possible a straightforward scientific epistemology, according to which an independent experimenter, about whom we ask no questions, investigates the natural phenomenon of knowing in 'the other one.' Such is perhaps the only *scientific* epistemology possible.⁴

The obvious importance of the experimenter's testimony in the operational scheme leads us to inquire as to the grounds of its acceptability. We have no formal yardstick by which to gauge an experimenter's worth, and yet we are faced with the fact that certain results do get into the scientific textbooks and that certain others are rejected, not because they satisfy or fall short of some absolute standard of merit, but simply because they meet with the approval or disapproval of other scientists. Each experimenter, then, depends upon the approval of his associates. If he reports seeing things which no one else is able to see, or if he hears voice which never speak to his colleagues, he is looked

⁴ Nothing attests more convincingly the futility of the approach to epistemology by way of the immediately given, a private affair of mine alone, than the fact that such procedures have never got us anywhere. Cf. the review of the situation given by P. A. Schlipp, *Philos. Sci.*, 2, 128-138 (1935).

at askance. If he proves dangerous, he is forcefully retired from the community of his fellows.

In the same manner, knowledge itself and all that passes for scientific truth is conditioned upon its social acceptance. The 'true' value of a physical constant which a physicist looks up in his handbook is true because physicists agree that it is true, and, if someone convinces physicists that the value is not true, it will thereafter be false. Of course each individual may think that he has his own private standards of truth, but then so do the inmates of our psychopathic hospitals. The only difference is that the scientist's standards (*vide infra*) conform to those of his associates. As all of the misunderstood Napoleons of the psychopathic wards could testify, from the social criterion of truth there is no appeal.

Insistence upon the social criterion of truth⁵ inevitably emphasizes the relativity of it. Truth is no more absolute than space or time. In fact science can speak of truth only as of a certain place and date, for what is true to-day was not true yesterday and may not be true to-morrow. Furthermore, truth to-day is not something definite and precise, of which one can take a convenient inventory, for agreement as to fact is never complete and opinion is in a perpetual state of flux. Knowledge, or truth, then, is not static, absolute or 'discoverable' in Newton's sense; it is dynamic, restless and relative.

So much, then, for a brief review of the operational basis of psychology. We see that psychology studies the behavior of a physical reacting organism and invokes the same principles of procedure as to the physical sciences. It takes for granted an experimenter capable of observing and recording objective phenomena and insists that his reports be made in terms for which there are operational definitions. Thus it refuses to recognize any but the public, reported aspects of behavior, and it acknowledges the social criterion of its truth. Psychology differs from

⁵ Philosophy, for all the questing it has done in search of truth, has, in the opinion of some of its own, for example, C. J. Ducasse, *Philos. Sci.*, 2, 121-127 (1935), failed to build up a body of *accepted* knowledge. To that extent it has no truth in the present sense. The same can be said of those other disciplines which produce less and less agreement the more earnestly they are pursued.

and is propaedeutic to physics in that it follows further back along the experimenter-regress, and inquires into the laws of behavior under which men spin hypotheses, observe events, and construct generalizations.

THE EMPIRICAL AND THE FORMAL

In common with every science psychology must divide its labors into two parts; it must perform experiments and it must describe the results. Conceivably the experimenter could acquaint his public with his activities by some sort of pantomime performed in their presence, but, fortunately, he does not have to resort to histrionics except in special cases. Instead he employs a common symbolic medium. He allows certain symbols (words, letters, operators, etc.) to stand for the various objects and relationships about which he desires to convey information, and these symbols he strings together according to some set of rules (logical, grammatical or mathematical). The experimenter then relies upon such a series of symbols, which he has set up, to take the place of his actual experiment, even after the apparatus has been dismantled and put back on the shelf.

Retreating a stage in the experimenter-regress in order to observe the behavior of the experimenter, we note that the process of juggling symbols may take two distinct forms. Between them we must distinguish sharply. Our experimenter may take pains to use only those symbols for which there is some concrete denotation and for which the meaning is operationally secure. In that case we say he is making *empirical* statements. On the other hand, he may use symbols for which there is no operational definition and put them together with regard only for the rules of syntax governing the use of those symbols. We say then that he is making *formal*⁶ statements (metaphysics, mathematics, hypotheses, etc.), devoid of *empirical* meaning. Of course, there is the third case in which, like Gertrude Stein, he would produce word

⁶ The word formal is used here to include such diverse fields as mathematics, metaphysics and certain kinds of fiction and poetry, because they have as a common feature the fact that they consist of arrays of symbols without operational meaning—regardless of whatever other diverse and important values they may have.

arrays with regard neither for syntax nor for empirical denotation, but we can consider such cases as atypical behavior.

The generation of acceptable *empirical* statements about the universe is the primary aim of science. Observing the experimenter in his effort to carry out the empirical task, we find him for the most part wrestling with the problem of fitting the syntactical shoe to the observational foot. He generally accepts the linguistic and mathematical conventions of the day—he leaves their probing to the Logical Positivists—and tries to utilize them to represent his observations and conclusions. As a criterion of his success he has the principles of operationism by which he can determine whether he speaks sense or nonsense.

Although, as we have noted, the success of the scientist in establishing his propositions and adding thereby to scientific knowledge depends upon the willingness of society to accept his statements, certain qualities, nevertheless, appear to characterize acceptable assertions. These qualities we may term *correspondence* and *coherence*. Propositions with empirical meaning must denote (correspond to) concrete verifiable operations. The degree of the correspondence, like the precision of the operations themselves, may vary over wide latitudes, for the evident reason that the criteria, by which some words (such as *institution*, *scientific*, etc.) are applied to objects or events, are not precise. However, there must always be some criterion of applicability or the word is operationally meaningless, i.e., it corresponds to nothing at all. The quality of coherence, on the other hand, is a characteristic of the symbolic system used in making a statement. If language is used, the rules of syntax for that language must not be violated. If mathematics is employed, the treatment must be consistent with mathematical convention which, at the time, is accepted as being coherent in logical structure. The problem of the revision of syntax in an effort to attain greater coherence is the problem of the philosopher, says Carnap.

Although efforts have recently been made to distinguish two types⁷ of empirical statement, the 'language of data' and the

⁷ The distinction has been made by M. Margenau [*Philos. Sci.*, 2, 48-72 (1935)] between *data* and *constructs* and by H. Feigl [*Philos. Sci.*, 1, 420-445 (1934)] between the *language of data* and the *language of constructs*.

'language of constructs,' it appears evident to the psychologist that the dichotomy is artificial. A statement about a datum is a statement about a construct. The simple statement, "I see red," is a complex response conditioned upon previous training and present circumstances of an organism, and differs only in complexity from a statement such as, "the oscillograph shows that the discharge takes place at a potential of 80 volts." The notion of a language of data is reminiscent of the concept of an absolute 'given,' and since it can be shown that the immediately given experience is defined operationally as consisting of relatively elementary differential responses, we had best dispense with the distinction between data and constructs. There are only constructs—of various orders of complexity and inference.

The activity of the scientist or philosopher when dealing with *formal* systems, constructing word arrays or manipulating mathematical signs, is an interesting behavioral phenomenon. As Wittgenstein⁸ said, "Philosophy is not a theory but an activity." In spinning a metaphysical system, in solving an equation, in making a logical deduction, or in writing the "Jabberwocky," men are behaving according to some learned pattern or according to a set of rules which tell them that, having done such and such, they must do so and so. Contrary to popular belief the product of such activity has no more relation to empirical reality than a musician's strumming *until* the nature of the correspondence between symbol and operation⁹ has been established. Thus the physicist does not prove something about the physical world when he solves the differential equation for the falling body¹⁰ unless and until he operationally identifies the meaning of each symbol of the solution. In fact more than one *formal* solution is possible

⁸ Quoted by R. Carnap, *Philos. Sci.*, 1, 5-19 (1934).

⁹ By *operation* is meant throughout this paper the physical, concrete operations which are differential reactions on the part of living organisms. These operations are in no sense imaginary or 'mental'—unless, of course, 'mental' is operationally defined. The mathematician also speaks of operations, but he refers to the manipulation of symbols according to rule, which he carries out on the *formal* level.

¹⁰ P. W. Bridgman has discussed the problem of making the formal 'model' fit the observations. See his *On the nature and limitations of cosmical inquiries*, *Sci. Monthly*, 37, 385-397 (1933).

in this case, but the physicist rejects as meaningless the solution involving negative velocity because it corresponds to nothing he can identify in the physical world. Similarly, the logical positivists insist that we reject as 'meaningless' all of the word arrays of metaphysics whose terms have no empirical denotation. Purely formal statements have form but are without content and are 'meaningless;' empirical statements likewise have form, but they are operationally verifiable and are 'meaningful.'

The psychologist would agree that the distinction must be carefully made between operationally founded and 'meaningless' statements, but whether he would thereby care to insist that the activity which leads men to make 'meaningless' statements should be arrested is another question. He thinks rather that it would be a dull world to live in if we excluded the 'formalizers,' for that would deprive us of the mathematician, the logician, the metaphysician, the poet, the theologian and the other manipulators of symbols. The logician and mathematician are particularly useful to him, because they develop the rules—the axioms, postulates and definitions—governing the use of the symbols upon which we rely for communication and which therefore determine the conventions that we follow. Because of their concern with the 'tools of thought' it would be plausible to regard logic and mathematics as the propaedeutic science, except 1) that logic and mathematics are not sciences in the empirical sense, and 2) that the experimenter-regress (*vide supra*) enables the psychologist to step back a stage and study the laws governing the behavior of the logician and the mathematician themselves. Needless to say, however, in this respect psychology has made meager progress toward filling its rôle of propaedeutic science. It pleads inexperience before such a complicated and difficult task.

Nevertheless, the perspective we have achieved in regarding formal statements as behavioral patterns, which need supplementary operations to make them empirically meaningful, enables us better to understand the nature of that difficult item, the hypothesis. An hypothesis is an array of symbols ordered after syntactical rules, the result of someone's activity as it were, but also an array which is without complete operational meaning.

However, the symbols may be given denotative power by subsequent observations, a point at which the hypothesis becomes an empirical statement. All prestatements, as well as hypotheses, represent behavior according to rule, i.e., the manipulation of symbols. The important thing about hypotheses is not, however, that they issue from a particular type of behavior and are empirically meaningless, but that they have important psychological effects on us. For certainly it is the hypothesis, the belief that such and such is the case before we have seen it, that accounts for most of the activities of scientists. A good hypothesis has a heuristic value which speeds men on to important discoveries, and which to a large extent determines the fruitfulness or sterility of an investigation.

Consequently operationism, which has been accused of being hypercritical and conservative to the point of defeat because it would purge science of the unoperational and the 'meaningless,' must answer that it does not intend to abolish the 'meaningless,' but merely to label it and to keep an eye on it so that it will not get mixed up with operationally valid concepts and thereby generate what Carnap calls pseudo-problems. Above all we need hypotheses just as we need mathematics; we need speculation, more and more daring, for our spirits are not fed and our imaginations are not fired by the recitation of dull, hard facts. Our present body of operationally valid knowledge is merely the starting place for new flights which will bring back increased knowledge—providing, of course, that we keep the landing field clear of unoperational obstructions.

Finally there is the problem of the emotional effects of 'meaningless' formal statements. Assertions about the acuity of the all-seeing eye of God are 'meaningless' by the operational criteria, yet many will insist that scriptural pronouncements have meaning to them personally. In this case something is meant by *meaning* different from the operational definition which we have adopted. Such statements are 'meaningless' in that no operations are prescribed for their verification, and the apparent meaningfulness to certain persons issues from the fact that emotional experiences and modifications of behavior result from hearing them. To call

metaphysical statements 'meaningless' is in no way to detract from their importance as forces in molding civilization. Such a classification merely emphasizes the fact that the justification for metaphysical statements is not to be sought in their ability to convey information, but must be found in their power, as word arrays, to modify attitudes and action. Music has precisely the same validation. Psychology regards both metaphysics and music as stimuli.

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