

WHEN IS SCIENCE?¹

BY HARRY A. GRACE

"WHY DO PSYCHOLOGISTS SPEND THE FIRST SESSIONS OF EVERY COURSE TRYING TO CONVINCE THE CLASS THAT PSYCHOLOGY IS A SCIENCE?"

Undergraduates majoring in the bio-physical sciences often ask questions like this. Heard often enough and answered indifferently, these questions begin to prey upon a teacher. In order to answer them for myself and my students, I began to examine psychological science. As I thought about psychology, paradoxes paraded before my mind. Let me present a few of the paradoxes which confound psychology, after which I shall offer a definition of science which reduces paradox and places psychology within the community of science.

"The spirit of science is one of loyalty to a Community of Interpretation. . . . The individual has made his discovery; but it is a scientific discovery only in case it can become, through further confirmation, the property and the experience of the community of scientific observers . . . this confirmation always involves a typical instance, or a series of instances, of Peirce's cognitive process called interpretation. . . . The final truth of each idea . . . that enters into this community, is due (when the goal is reached) neither to its 'works' nor to its workings, but to its essential spiritual unity in and with the community. . . . That the scientific community itself exists, is therefore one of the most important principles used in the natural sciences. Often this principle is more or less subconscious. It is seldom adequately analyzed . . . Whoever says, 'I have discovered a physical fact,' is not merely reporting the workings of his own individual ideas. He is interpreting. He is therefore appealing to a community of interpretation. . . . All scientific research depends upon loyalty to the cause of the scientific community of interpretation."²

One rat, recently returned to his cage, runs to a fellow rat and exclaims, "You know, I've got Dr. Zilch conditioned!"

"How so?" asks the second rat.

"Well," replies the first, "everytime I press the bar, he gives me food!"

When one watches the conditioner slave over his experiment, the question arises as to who conditions whom. Of course, anomalies exist in other fields of psychology. Large sums of money are spent to find that ear plugs reduce noise. Studies indicate that first impressions are more valid for predictive purposes than subsequent information. Anxiety appears to be related to eyelid conditioning, at least for those queer persons who willingly allow air to be puffed into their eyes.

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¹"If we would have new knowledge, we must get us a whole world of new questions." Langer, S. K., *Philosophy in a New Key* (New York: Penguin, 1948), p. 10.

²Royce, J., *The Problem of Christianity*, Vol. II (New York: Macmillan, 1913), pp. 227-228, 231, 235, 245, 247, 249, 252.

Critical thinking is related to one's having taken courses in logic, but persons who take such courses have higher IQ's to begin with. Psychotherapy changes people, we believe, although experiments on therapy ignore control groups. There is more aggression in democracy than autocracy, at least inside the laboratory. Analysis reveals three factors in behavior—the evaluative, the cognitive, and the active. But Wundt deduced the same triumvirate—feeling, thinking, doing—when psychology was a pup. Who has validated whom?

Paradoxes weaken a science which cannot integrate them. At present, paradoxes weaken psychology. “. . . The object is not to do away with *difference* but to do away with *muddle*. . . . The object of accurate information is not to overcome difference but to give legitimate play to difference. . . . There is now some basis for significant difference. Difference based on inaccuracy is meaningless. We have not done away with difference, but we have provided the possibility for fruitful difference.”³ Professionalism threatens to replace the chaos of paradox with the certainty of codes, anarchy with orthodoxy, and orthodoxy stifles science worse than anarchy itself.

Ernst Mach had this to say about his science. “. . . The physicists are on the surest road to becoming a church, and are already appropriating all the customary means to this end. To this I simply answer . . . I hereby abandon the physicist manner of thought, I will be no regular physicist. I will renounce all scientific recognition; in short the communion of the faithful I will decline with best thanks. For dearer to me is freedom of thought.”⁴

With slight revision this quotation might find favor with some psychologists today. Codes have already made their way into psychology.⁵ Therefore, there is good reason to redefine psychological science before it becomes a church.

WHEN IS AN INVESTIGATION SCIENTIFIC?

An investigation is scientific when the method it employs is appropriate to the problem it seeks to solve. This principle delimits the community of scientists.⁶

The investigator, to be called a scientist, may choose either his problem or his method—not both. Having chosen his problem, it is his responsibility as a scientist to choose the method most appropriate to the problem's solution. On the other hand, he may prefer a method. To be responsible to the scientific community, he must employ that method toward the solution of appropriate problems. Both the freedom of selection and the responsibility of appropriate

³Follett, M. P., *Creative Experience* (New York: Longmans, Green & Co., 1924), p. 6.

⁴Carus, P., “Mach and His Work”, *Monist*, 1911, 21, pp. 19–42.

⁵Committee on Ethical Standards for Psychology, *Ethical Standards for Psychology* (Washington, D.C.: American Psychological Association, 1953).

⁶Traditionally, psychology has used a bio-evolutionary classification. Psychology has been imperialistic within this taxonomy. Psychologists have become interested in infrahuman animals as well as suprahuman organizations. Recently, psychology has added the machine (infra- or suprahuman?) to its area of concern. The distinction between living and non-living phenomena has doubtful usefulness in psychological science. Some of our paradoxes may be traced to this archaic taxonomy which either lumps all life together or categorizes life more distinctly than behavior warrants.

coordination of problem and method are conditions for membership in the community of science.

Questions are not meaningless, *per se*.⁷ They only become meaningless when they do not fit the dimensions of a method. All questions cannot be answered by the same technique, whether it be a T maze, an ink blot, F scale, a tachistoscope, or a poem. To attempt to investigate all questions by the same method *makes the question meaningless for the method*.

The dogmatic misuse of positivism and operationalism by some psychologists has tended to reduce the science. The operationalist so thoroughly enjoys the clean experiment, the cute design, that he has long since forsaken science for sanitation. He jeers at Herbart for having said that psychology would never become a laboratory science. But Herbart's statement still stands. The operationalist has defined psychology in such a manner that Herbart's interests are excluded from the laboratory. Operationalism, by its parochial emphasis upon immediacy, its rejection of continuity and reason, supports an orthodoxy which threatens psychological science. Bridgman recognizes this trend when he comments, "It has, in fact, been a surprise to me that, since the publication of my book, so much of the concern of others has been with abstract methodological questions suggested by the endeavor to erect some sort of philosophical system rather than with attempts to follow the more concrete and obvious leads An operational analysis is always possible, that is, an analysis into what was done or what happened. An operational analysis can be given of the most obscurely metaphysical definition . . ."⁸

Methods are not meaningless, *per se*. Methods become meaningless insofar as they are inappropriate to the dimensions of the problem they are supposed to solve.⁹ Before indicating a taxonomy of methods, I wish to emphasize how this principle reconstructs a community among psychologists and between psychology and other sciences. "The problem raised by philosophical diversity is essentially the same as that produced by specialization. It is the problem of forming a community in the absence of communication."¹⁰

THE STRATEGY OF INVESTIGATION

The investigator enters his study with a strategy. For limited (minutely extensive) and immediate (fleeting temporal) problems, one method may be more valid than another. "If a result is to be used merely to confirm a result of an independent investigation, it may have a high value even though its probability is not very high. But if it is only to be used in combination with other

⁷Bridgman, P. W., *The Logic of Modern Physics* (New York: Macmillan, 1946), pp. 28-31.

⁸Bridgman, P. W., "Remarks on the Present State of Operationalism", *Scientific Monthly*, 1954, 79, pp. 224-226.

⁹The concepts of time and space, or power and reason, provide pragmatic coordinates for the classification of psychological events. We select an event, assessing the amount of space it occupies and the power it exemplifies. These are extensive aspects of the event. We assess the intensive aspects of the event by the time over which it endures and the continuity, sequence, or reasonableness it portrays. Having made these judgments of extension and intension, (always colored by our initial selection of the event itself), we may classify an event accordingly. Methods may also be classified according to the scope of their extension and intension as this paper will indicate.

¹⁰Hutchins, R. M., *The University of Utopia* (Chicago: University of Chicago Press, 1953), p. 49.

results, very little will be gained by increasing its probability far beyond the probabilities of those others. . . . But where a high degree of exactitude and probability is unattainable, that is no reason for refusing to accept such knowledge as we can attain."¹¹ By valid, I mean appropriate to the dimensions of the problem. Thus, for immediate, reversible, finite decisions about a person, the Rorschach has validity.¹² So do palm reading, the crystal ball, first impressions, and a host of other techniques. But if men's lives depend upon the assessment of their personalities (the implication being that once we decide we may never change our mind), no battery of tests would be too large to facilitate this decision. No ink blot or crystal ball would alone be valid. Instead, we would demand an answer be repeated (time) under many different circumstances (space) because the decision of life or death is infinitely extensive and intensive.

From the design of a study we can predict what events the investigator will call data. For example, aggression may be higher in democratic than autocratic atmospheres. However, extend the space of investigation to include the hall outside the laboratory. Then greater aggression is expressed in autocratic rather than democratic atmospheres. Autocracy accomplishes more work in a given session than democracy. Extend the time to include session after session and efficiency decreases in autocracy while it increases in democracy. The criterion of learning is reached with twenty correct consecutive discrete trials. But the student asks, "Might not the subject choose incorrectly if he were run on the twenty-first trial?" This is not naive. "We must always be prepared some day to find that an increase in experimental accuracy may show that the two different sets of operations which give the same results in the more ordinary part of the domain of experience, lead to measurably different results in the more unfamiliar parts of the domain. We must remain aware of these joints in our conceptual structure if we hope to render unnecessary the services of the unborn Einsteins."¹³ The question about the twenty-first trial indicates that changes in the extension or intension of an event (a) imply different strategies of investigation, (b) supply different data, and (c) comply with different theories.

The investigative procedure flows something like this. Uneasiness irks the psychologist. Reflecting upon it, he selects a particular aspect to investigate. As he forms an hypothesis, he becomes aware of its appropriateness to the source of his uneasiness. To test the hypothesis, he selects a stimulus. He selects subjects. From the interplay among himself as investigator, the stimulus he has selected, and the subjects he has chosen the data are derived. Upon what do the data depend? The method of investigation, the stimulus, and the subjects. But each of these has been selected by the investigator. Thus, he actually determines his data, too.¹⁴ Data are not indeterminate, they are determined by the

¹¹Hartshorne, C. and Weiss, P., *The Collected Papers of Charles Sanders Peirce*, Vol I (Cambridge: Harvard University Press, 1931), 1: 86.

¹²Cronbach, L. J., "Report on a Psychometric Mission to Clinicia," *Psychometrika*, 1954, 19, pp. 263-270.

¹³Bridgman, P. W., *The Logic of Modern Physics*, *op. cit.*, p. 24.

¹⁴Logicians, mathematicians, and related linguists improve the appropriateness to reality of problem selection and hypothesis formulation. Likewise, it is their special concern to improve the correspondence between inference and the results of investigation.

investigator. That is why we must have a community of investigators, that we may share and criticize one another's selections. Science is such a community.

We can assess the scientific competence of a psychologist by the correspondence of his method, logic and technique, to the problem he wishes to solve. Borderline investigations are no shame. "The man who is working in the right way to learn something not already known is recognized by all men of science as one of themselves, no matter how little he is informed. . . . So if a man pursues a futile method through neglect to inform himself of effective methods, he is no scientific man; he has not been moved by an intelligently sincere and effective desire to learn. But if a man simply fails to inform himself of previous work which would have facilitated his own, although he is to blame, it would be too harsh to say that he has violated the essential principles of science. If a man pursues a method which, though very bad, is the best that the state of intellectual development of his time, or the state of the particular science he pursues, would enable a man to take . . . we perhaps cannot call them scientific men, while perhaps we ought to do so. Opinions would differ about this. They are, at any rate, entitled to an honorable place in the vestibule of science. A pretty wild play of the imagination is, it cannot be doubted, an inevitable and probably even a useful prelude to science proper. For my part, if these men really had an effective rage to learn the very truth, and did what they did as the best way they knew, or could know, to find it out, I could not bring myself to deny them the title."¹⁵

Studies which fall between methods are admittedly less scientific. As logic and technology evolve, that which was borderline to the science becomes central. Psychophysics, its very name implies, lay on the border. Later it became central to psychology. Today, psychophysics might be called borderline physiology, because psychologists often exclude this topic, along with human heredity and development, from their definitions of the science. And the psychophysicists docilely accept the title "physiologist" in preference to the professional tinge which surrounds "psychologist."

Failing to define a community of psychological scientists, allowing professionalism the day, psychology stands to lose its vital organs—psychophysics, comparative and physiological psychology, human heredity and development—as it has long since lost its mind and soul.¹⁶

A TAXONOMY OF INVESTIGATIVE TECHNIQUES

"It comes to this, that sciences must be classified according to the peculiar means of observation they employ. So too, the great landmarks in the history of science are to be placed at the points where new instruments, or other means of observation, are introduced. On the other hand, if classifications are to be restricted to sciences actually existing at the time the classifications are made, the classifications certainly ought to differ from age to age. If Plato's classification was satisfactory in his day, it cannot be good today; and if it be good now, the inference will be that it was bad when he proposed it."¹⁷

¹⁵Peirce, *op. cit.*, 1: 235.

¹⁶The classification of psychological events along an evolutionary continuum from infrahuman to human to suprahuman, mitigates toward emphasizing suprahuman psychology. Psychologists whose concern is farther down the scale soon fade away.

¹⁷Peirce, *op. cit.*, 1: 101–102, 1: 203.

Taking a cue from Peirce, we may define psychological science by classifying the techniques psychologists use in their investigations. Classifying events by their extension and intension wastes neither the current emphases upon psychological practice nor the traditional emphasis upon principles of behavior.

The graphic representation of infinity has heuristic value for my argument. Graphically, infinity runs in two directions, from the infinitely small to the infinitely large. Thus, no less a scientist than Albert Einstein, although he commented on the state of culture shortly before his death by suggesting that he might prefer the profession of plumbing, sought answers to the riddle of the universe (infinitely large) in the nucleus of the atom (infinitely small). The same graph loses its value if it leads us to believe there are two infinities. No matter how we graph it, infinity is one. Is it any wonder then that the creativity of the artist and the laboratory experimenter appear so similar? After all, both deal with infinity. The artist's world is macrocosmic, infinitely large, and the laboratory experimenter's microcosmic, infinitely small. Nonetheless, creative investigators find mutual concern in cosmic problems.

This brief discussion of infinity and the relations between creative artists and experimenters suggests the point of the taxonomy proposed in this paper. I should like to classify the techniques of investigation used in psychological science into three classes: discovery, uncovering, and recovery. Then, assessing the extension and intension of each technique, I should like to arrange them in order from most extensive and intensive (macrocosmic) to least extensive and intensive (microcosmic). When this task is accomplished, the science of psychology should be clear, and the place of psychology among other sciences better understood.

Discovery. The techniques of discovery enable the investigator to control his research quite thoroughly. These techniques afford conclusions of great general value but little immediate importance. They permit the investigator to manipulate his subjects. Thus, he may create situations which do not presumably exist in nature and discover what did or might exist. Two subclasses are important: reflection, as in fiction or in theory; and experiment, as in the laboratory or in the field.

The investigator who uses fiction need obey few rules to gain an understanding of the problem. He may create a unique situation and follow it to its conclusion. The language of the arts and literature lie at his disposal, and even they may be manipulated at whim.¹⁸

Rules of logic predominate in theoretical reflection. The investigator may write a new logic, but he must be consistent with his premises throughout. Mathematics is the primary language for theorization.

The laboratory experimenter conducts his study in a special environment. He manipulates his stimuli, his subjects, and their situation to suit the problem under investigation.

In the field experiment, the investigator may manipulate some of the variables, but only within the confines of the on-going situation.

Uncovering. The class of techniques known as uncovering allows the investigator to question his subjects. He may inquire about past events, present

¹⁸Oehser, P. H., "The Lion and the Lamb", *American Scientist*, 1955, 43, pp. 89-96.

behavior, or future plans. His controls lie more in the statistical analysis of his results than in his ability to manipulate the environment. Three techniques are important in this category: the poll, the test or survey, and the depth interview.

The poll gathers brief answers about a few issues from a wide sample of people.

The survey explores how a particular group of people reacts to different aspects of one topic.

The depth interview gathers a great amount of related data from a few informants.

Recovery. Techniques of recovery provide insight into behavior in spite of the investigator's inability to manipulate or question the subjects directly. The investigator attempts to reconstruct the pattern of action. His observations may be contemporaneous or historical. *Product analysis* focuses upon either the signs or symbols subjects emit. *Process analysis* focuses upon the continuity of behavior.

Sign analysis does not manipulate the environment but may take place during or after the action. The investigator must be skilled in observing, recording, and treating data in order to provide adequate controls.

Languages provide the data for *symbol analysis*. Music, art, dance, sport, or words are some of the forms analyzed. The investigator need not be present when the forms are issued. His controls lie in the choice of his sample and the analysis of his results.

Biography is a technique of process analysis. Whether the study selects a brief episode in a subject's life or the entire life itself, biography focuses upon the sequence of events. The data are not isolated incidents but the continuity which binds events together.

History, a second technique of process analysis, concentrates upon assemblies of subjects. It seeks to recover events which occurred simultaneously or sequentially. The investigator may select his limits but he has little choice of his subjects and no ability to manipulate them.

SQUARING THE CIRCLE

Having presented these eleven techniques and classified them as either discovery, uncovering, or recovery, I will now assess the limits of extension and intention each technique implies.¹⁹ Ranking each technique according to its extension and intension, I arrive at the graph in Figure 1. I cannot argue the finality of my assessment of these techniques. I only wish to delimit a community of science in which psychology finds a proper place, using as the definition of science the appropriateness of a method to a problem.

The story is told of a pint-sized convict who had been trying to split a boulder with a tack hammer. Before quitting time, his giant buddy obligingly pulverized the boulder with one blow from his sledge hammer. The shorter convict looked up at his smiling confederate and quipped, "Do you think you could've split that rock if I hadn't softened it up for you?"

¹⁹By extension I refer to the space (number of stimuli, number of subjects) and power (ease of subject stimulation and manipulation, importance of subjects) each technique allows. The intension of the technique includes its time-sample or duration and the sequence, continuity, or reasonableness it permits.

It is questionable that the problem of international war and peace can be solved, even softened up, by T mazes, attitude surveys, ink blots, etc. All the investigator gets from such techniques is a "whee-feeling". And that false sense of accomplishment is of doubtful value to science. Nor will poems, however well written, replace the dark room and the filter in the study of light adaptation. Poems may even get in the way of answering such psychophysical problems. For microcosmic questions there is no substitute for the "wee-feeling" which arises from employing microscopic techniques.

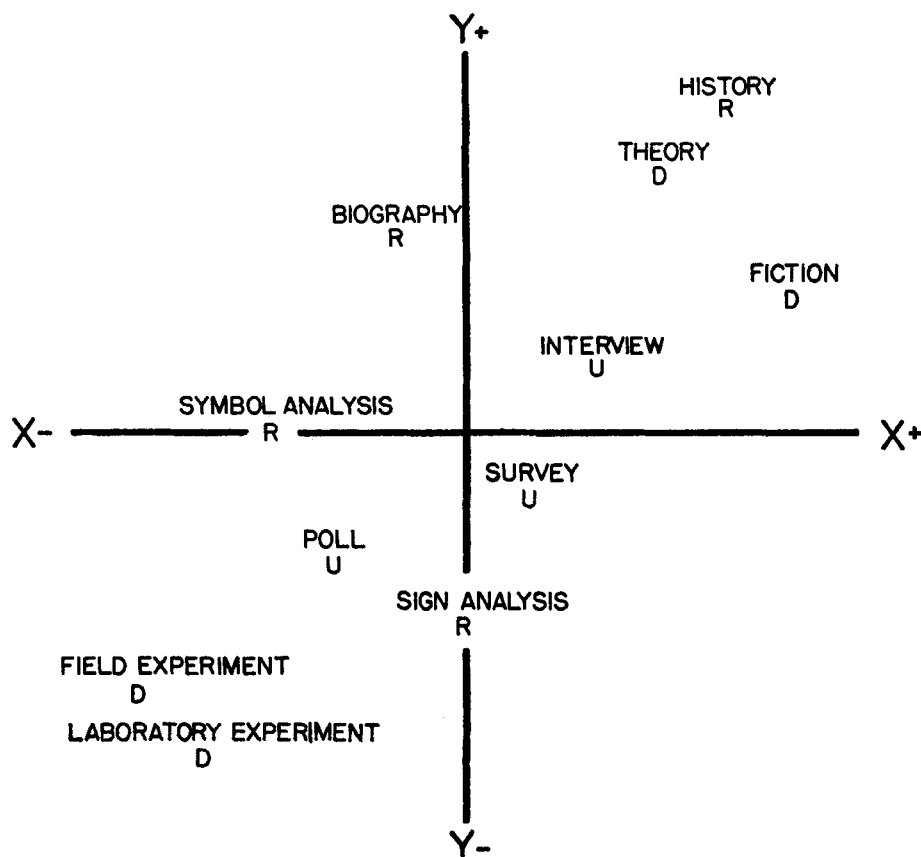


FIGURE 1

Techniques of investigation plotted according to their extension (X), space-power, and intension (Y), time-reason. Each technique is classified as discovery (D), uncover (U), or recovery (R).

The community of science embraces all methods. It expects some misapplications as methods are tried on for size. Nor is the community threatened by the diversity of problems. It is rather comforting to know that other scientists are at work on polio, atoms, vision, and so forth, that I might concentrate on problems of my own choosing. We respect as fellow scientists men who select different methods for their problems, and we expect to receive their respect in

return. "In the beginning of this century, chemotherapeutic research produced results that only a few years earlier, would have been regarded as impossible. Personally, I am convinced that coming studies in the field of *social psychology* will enable us to understand the nature of mental diseases and of many nervous disorders. If I were sixty years younger I should not hesitate to devote myself to the study of social psychology or psychiatry."²⁰ We would welcome Dr. Von Euler-Chelpin today, for Prof. L. F. Richardson, retiring from physics a few years ago, has already made significant contributions to the social psychology of war and peace. If knowledge is unified, what right have we to believe that a specialist is one aspect of science might not contribute to another? Science is a community of difference, not of deference. Difference in problems and methods is the basis for confidence among scientists.

Historically, a science flows back and forth from fiction to laboratory experiment and return. Any single investigation runs a similar gamut. Rather than a straight line from discovery through recovery, these techniques find better representation as a circle.

WHEN AN INVESTIGATOR IS SCIENTIFIC

Daily, we drive mature scientists out of psychology. Daily, we discourage the immature from pursuing a career in psychological science. When a person employs the appropriate method to the solution of his problem, welcome him into the community of investigators called science! He enters as a peer. Rank, status, and privilege are professional bogies with no place in the free community of scientists. As a member of the scientific community, expect him to make public his efforts and try again. He is free to select any problem. He is free to use any method. It is his responsibility as a scientist to coordinate the problem and the method, for in so doing he advances knowledge and expands the community of science.

Psychologists belong to this community of scientists. "A few years ago, indeed, regenerate psychology, in the flush of her first success, not very wisely proposed to do without metaphysics; but I think that today psychologists generally perceive the impossibility of such a thing. . . . Soon we may hope that all psychologists, on their side, may be equally at one that all phenomena without exception are purely psychical for the purposes of psychics."²¹ Like the common law, itself an institution of a free and responsible society, science requires housecleaning to bring it up to date. With each new-found integrity the goodness of fit between methods and problems is improved. However, the common law rests with peers. Hierarchies introduce dogma. The common law integrates differences without regard for deference. Differences among the community of scientists strengthen psychology, strengthen science, and strengthen society. This definition of science, placing psychology in its proper setting, dispells anarchy, and with anarchy it dispels the symptoms of professional duplicity and the threat of orthodoxy which prevail.

²⁰Von Euler-Chelpin, H., "Place of Science in Society Today", *Scientific Monthly*, 1954, 79, pp. 365-367.

²¹Peirce, *op. cit.*, 1: 250, 1: 252.