Psychology and Scientific Research. I. The Nature of Scientific Inquiry

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The traditional code of science—that is, the objectives sought and the methods of investigation—cannot satisfy the requirements of our critical times, and this is why science has failed to measure up to the opportunities and obligations before it. The generally accepted ideas of what natural science is and what it is for are out of date and need radical revision.—C. J. Herrick (*8*, V)

A FEELING OF URGENCY for a more adequate understanding of man and his social relations can be sensed in today's intellectual atmosphere. People are becoming more and more anxious about the ability of psychologists and social scientists to help solve the problems arising from our technological advances and from the swift social transitions they leave in their wake. But unfortunately what Herrick has said about the natural sciences applies especially to those sciences which deal with man—psychology and the social sciences in general. Moreover, in these sciences, in contrast to the physical sciences, there seems to be less agreement as to what constitutes significant research.

Obviously, an increase in our understanding of man can come about only as we extend our empirical knowledge and improve our formulations through research of demonstrated significance. And before that is possible, we must increase our understanding of the scientific process through which discoveries are made. But sometimes the scientist's interest in building up the content of his discipline sidetracks him from a consideration of the scientific process itself and creates a lag in the understanding and improvement of scientific tools. What follows is an attempt to clarify our thinking about the nature of scientific research in those fields which take upon themselves the primary responsibility of accounting for man's thoughts and behavior. Only then will such research accomplish what we have a right to expect of it.

We shall first consider the nature of scientific inquiry, trying to find out why man pursues scientific inquiry, anyway—what function it serves him, and what steps seem to be involved. We shall then distinguish between scientific inquiry and scientific method—a distinction which seems necessary to avoid certain pitfalls and to assure scientific progress. Then we shall try to point out some of the specific implications to be derived for psychology from a better understanding of the nature of scientific inquiry and the role of scientific method and we shall indicate to what degree science can be "objective." Finally, some suggestions will be made which might accelerate the kind of scientific research that will increase our understanding of man.

The apparent reason for scientific inquiry is essentially the reason for any inquiry—to solve a problem. Scientific inquiry can never be understood if it is somehow put on a pedestal and viewed as something remote and apart from man's everyday activities. "Science," says Conant, "emerges from the other progressive activities of man to the extent that new concepts arise from experiments and observations" (*1*, 24).

These activities of life are carried through in an environment which includes people, artifacts, the phenomena of nature. Man's only contact with this environment is through his senses. And the impressions man's senses give him are cryptograms in the sense that they have no meaning unless and until they become functionally related to man's purposive activities. The world man creates for himself through what Einstein has called the "rabble of the senses" is one that takes on a degree of order, system, and meaning as man builds up through tested experience a pattern of assumptions and expectancies on which he can base action.

Man builds up his assumptive or form world largely in an unconscious and nonintellectual way, in the process of adjustment and development as he goes about the business of life, that is, as he tries to act effectively to achieve his purposes. Man often uses many of his assumptions without being at all aware of them, such as those involved in reflex activity, habits, stereotypes, and a whole host of perceptual activities. Man is aware of other assumptions from time to time as they become relevant to the situation at hand, such as loyalties, expectancies, ideals. Still

others, such as intellectual abstractions, can be brought to voluntary recall. Man's actions cannot be effective unless and until he builds up an assumptive or form world that has some degree of constancy and verifiability.[1]

What man brings to any concrete event is, then, an accumulation of assumptions, of awarenesses, and of knowledge concerning the relatively determined aspects of his environment as derived from his past experiences. But since the environment through which man carries out his life transactions is constantly changing, any person is constantly running into hitches and trying to do away with them. The assumptive world a person brings to the "now" of a concrete situation cannot disclose to him the undetermined significances continually emerging. And so we run into hitches in everyday life because of our inadequate understanding of the conditions giving rise to a phenomenon, and our ability to act effectively for a purpose becomes inadequate.

When we try to grasp this inadequacy intellectually and get at the why of the ineffectiveness of our purposeful action, we are adopting the attitude of scientific inquiry. Man as scientist tries to understand what aspect of his environment is responsible for a hitch and then calls upon what knowledge he has that is relevant to an understanding of the determined, predictable nature of the particular phenomenon in question. Modern man uses the scientific method as a tool because he has found empirically that he can increase his understanding and act more effectively if his pursuits are guided by some knowledge concerning the determined aspects of the phenomenal world. G. H. Mead pointed out (*9*, 41) that

> . . . Every discovery as such begins with experiences which have to be stated in terms of the biography of the discoverer. The man can note exceptions and implications which other people do not see and can only record them in terms of his own experience. He puts them in that form in order that other persons may get a like experience, and then he undertakes to find out what the explanation of these strange facts is.

Since the scientist's acquired purpose is to increase his understanding of a certain range of phenomena, when he experiences a hitch in his understanding of such phenomena he tries to bring to conscious awareness the reason for the hitch, that is, he tries to formulate intellectual concepts that will explain away the hitch. He does this by examining the probable conditional relationships except for which he, as an experiencing individual in a concrete situation, would not be faced with the hitch. He abstracts out of the hitch-situation those aspects he believes are probably necessary to his understanding of the original hitch. In his inquiry, the scientist arbitrarily treats these abstracted aspects of a phenomenon as if they existed in their own right. He does not do this simply because he wants to but because he has to, in order to recall and manipulate the phenomenon intellectually. The abstractions man is able to form have on him what Dewey and Bentley characterize as a tremendous "liberative effect," making possible the voluntary, controlled conceptual thinking necessary for scientific inquiry and for the use of scientific method.

From this point of view, we might say in general that science is an activity designed by man to increase the reliability and verifiability of his assumptive world. For it would appear that in the last analysis any scientific pursuit—no matter how abstruse it seems—is carried on because it is somehow of concern to man. Science is the human effort to understand more about nature and human nature in verifiable, determined terms. The word *determined* is used here in the scientific sense as meaning high in prognostic reliability. From this it is clear that real progress in any science involves an awareness of our assumptive worlds, a consciousness of their inadequacy, and a constant, self-conscious attempt to change them so that the intellectual abstractions they contain will achieve increasing breadth and usefulness. Real progress in science means much more than merely adding to existing knowledge.

The processes involved in scientific inquiry would seem to be somewhat as follows: (1) sensing the inadequacy of the conceptual aspects of our assumptive world, thereby being faced with a problem for which we must seek an answer; (2) deciding on all those aspects of a phenomenon that might have a significant bearing on the problem: deciding on those aspects except for which the functional activities in question would not exist; (3) picking out from the various aspects assumed to be involved those that seem most important in terms of the original hitch we faced and that will serve as bases for standards we can think about and manipulate; (4) working out some method of changing those aspects we have chosen as variables or bases for standards and conducting our empirical investigations accordingly; (5) modifying our assumptive world on the basis of the empirical evidence concerning the validity of formulations that have resolved an immediate problem.

The solving of the immediate problem will automatically give rise to new hitches and the above process constantly repeats itself.[2]

[1] The nature and function of man's assumptive or form world is much too large a subject to treat in any detail here and must be reserved for later consideration.

[2] There seems to be a striking similarity between the processes used in scientific inquiry and the processes man makes use of in building up the assumptive world. Both science and common sense can be regarded as functional activities man uses in carrying out his life transactions. And the

Specifically, it seems that scientific inquiry has two major functions for man. First, it provides man with a bundle of what are called "scientific facts." This bundle is composed of his up-to-the-now understandings of the determined, predictable aspects of nature and is used by him for purposes of prediction and control. There are essentially two varieties of these scientific facts: general statements of relationships of determined aspects of nature which we refer to as "scientific laws" and which, in the physical sciences, tend to be expressed in mathematical formulas; second, applications of these general laws to concrete situations for purposes of verification, specific prediction, or control. The characteristic of all these generalized scientific laws is that they disclose predictable aspects of types of phenomena no matter where or when they occur, irrespective of actual concrete situations.

A second function of science is that it provides a conceptual reorganization of the knowledge man has already acquired of the determined aspects of nature. Here we are trying to increase our range of understanding, or, as Dewey and Bentley phrase it, to improve our "specification," that is, our accuracy in naming (*4, 5*). Here, for example, the specifications involved in relativity are more accurate namings of phenomena than are Newton's concepts, and in this sense, Newton's concepts are not to be regarded as "wrong." This function of science includes that of increasing the range of man's conceptual knowledge through the discovery of more and more predictable aspects of nature that up to the present time remain undetermined.

Understanding and prediction. The aim of science is often defined as the attempt to increase the accuracy of our predictions. While the accuracy of predictions is clearly a most important criterion of progress in scientific formulation, emphasis on prediction alone can easily obscure the more fundamental aim of science covered by the word *understanding.* When we use the word understanding we are giving emphasis to the importance of increasing the range of our conceptual knowledge. Increased accuracy of prediction will be an inevitable coproduct of increased understanding in this sense. Any increase in understanding is also inevitably accompanied, sooner or later, by an increased ability to control variables and to apply our knowledge. Understanding also avoids the implication of a rigid determinism which seems, among other things, to be inconsistent with the fundamental indeterminism of modern physics.

Every scientific investigator must bear in mind that it is impossible for scientific research to disclose the unique specificity involved in any one actual occasion—e.g., the student of modern physics knows that there is no law governing the behavior of an individual atom. And the investigator must also remember that it is impossible to predict with any complete accuracy the specific nature of growth and emergence, which are themselves undetermined. While it is impossible to determine the undetermined nature of emergence, it is still possible to increase our scientific knowledge about emergence through understanding more about the relatively determined phenomena immediately related to these undetermined emergent aspects. For example, we may hope to understand more about the extent of the undetermined field; to understand more about the conditions which make it possible for the undetermined aspects to emerge. In other words, our understanding of emergence can improve only insofar as we become more and more aware of the boundaries of our determined world.

It is here that many of those who equate science with prediction or who use a narrow working definition of operationism are also those who will say they want nothing to do with the speculations of philosophy. And yet it is only by taking the philosopher's point of view, by bringing in freely all factors that might conceivably be involved in a single situation, that we can become aware of the boundaries of our up-to-the-now, determined scientific world. In discussing the role of philosophy, Conant writes that "there must be constant critical appraisal of the progress of science and in particular of scientific concepts and operation" (*1,* 13 f.). In their book on *The evolution of physics,* Einstein and Infeld repeatedly emphasize the new philosophic views which have both helped to evolve and have evolved from physical research. Any scientific investigator who pushes his

method of scientific inquiry seems in many ways to be an unconscious imitation of those age-old processes man has employed in his common-sense solutions of problems. In common-sense activity, the assumptions and awarenesses on which man depends for effective action are the hypotheses he has built up from his many experiences: weighted averages he unconsciously uses to give him a high prognosis for effective action.

There are, however, certain important differences between the steps involved in pursuing scientific inquiry and the apparent processes that constitute common sense. A most important difference is the fact that in using scientific inquiry, man is the operator who decides what he is going to operate on and how. In an everyday life situation, however, man is not only the operator but he is also being operated on and must carry out his activities in the midst of the situation itself. When we meet hitches in everyday life and try to overcome them with hunches for effective action, we test these hunches by the action itself in a more or less insightful, more or less conscious way. In scientific inquiry, on the other hand, hunches are tested by controlled experiments and a deliberate attempt is made to intellectualize the processes involved (cf. *3*).

field of inquiry beyond the realm of the determinable and the repeatable out into the no man's land of emergence will inevitably become entangled with metaphysical problems. In so doing, he can hope that what is metaphysical for him today can tomorrow be part of the understood, physically determined, repeatable, and verifiable.

Transactional observation. Our own philosophical basis for our thinking concerning the nature and function of scientific inquiry and scientific method should be made explicit. We are using as our take-off point what Dewey and Bentley have referred to in a series of articles as a "trans-actional approach."[3] What they mean by the term *transactional* can best be gathered by their own words. "Observation of this general (transactional) type sees man-in-action not as something radically set over against an environing world, nor yet as merely action 'in' a world, but as action *of* and *by* the world in which the man belongs as an integral constituent" (*4,* 228). Under this procedure all of man's behavings "including his most advanced knowings," are treated as "activities not of himself alone, nor even as primarily his, but as processes of the full situation of organism-environment" (*6,* 506). "From birth to death every human being is a *Party,* so that neither he nor anything done or suffered can possibly be understood when it is separated from the fact of participation in an extensive body of transactions—to which a given human being may contribute and which he modifies, but only in virtue of being a partaker in them" (*3,* 198).

Dewey and Bentley distinguish this transactional procedure from two other procedures which they feel have largely dominated the history of science up till now. First is what they call the antique view of "self-action; where things are viewed as acting under their own powers." Second is the interaction view of classical mechanics, "where thing is balanced against thing in causal interconnection." In transactional observation, "systems of description and naming are employed to deal with aspects and phases of action, without final attribution to 'elements' or other presumptively detachable or independent 'entities,' 'essences,' or 'realities,' and without isolation of presumptively detachable 'relations' from such detachable 'elements' " (*6,* 509).[4]

While it is easy enough to understand this point of view intellectually, it is not nearly so easy to put it into operation in pursuing actual scientific inquiry. It tends to go against the grain of the psychologist's working procedures to regard any formulation merely as a certain "connection of conditions" (*2,* 217). And it is perhaps particularly difficult for psychologists to understand the full implications of the transactional point of view, because, as Dewey and Bentley have pointed out, "The interactional treatment, as everyone is aware, entered psychological inquiry just about the time it was being removed from basic position by the physical sciences from which it was copied" (*7,* 546). But we must remember that psychology, by comparison, is still in its infancy, that the transactional approach, which Dewey and Bentley trace to the preface of Clerk Maxwell's *Matter and motion,* dated 1877, antedated the first psychological laboratory.

[3] Since this article was written, Dewey and Bentley have brought together in a single volume, *Knowing and the known* (Boston: Beacon Press, 1949) references *3, 4, 5, 6,* and 7 cited here together with other articles previously published by them.

[4] In citing these distinctions made by Dewey and Bentley we are not implying (and they may not be) that in our own view either self-action or interaction can by any means be completely ruled out in any adequate explanation. Self-action is seen in the behavior of the simplest bodily cell, in the uniqueness of individual behavior, in the behavior of "nations," etc., while interactional assumptions appear to be essential first steps in providing an intellectual grasp of the form for the flow of transactional processes. The role of self-action and interaction in an inclusive transactional view must be left open as a problem, and cannot be considered here in detail.

(This is the first of a series of three articles.)

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