Methods Toward a Science of Behavior and Experience

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Custom Contents

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What Is Science?

Science is above all a human activity. One obvious meaning of this is that science is performed by people. Another equally accurate meaning is that all people perform science in some form. After all, the methods of science are simple extensions of the ways all people learn about their world. Science in many ways is similar to the way we have been learning about the world since we were infants. We learn through interacting with our world. Consequently, each of you knows this aspect of science well because you have been using it in one form or another since you first began toddling about and discovering the world. You probably know much more about the scientific method than you think you do.

Watch a young child. When something catches his or her eye, the child must examine it, study it, observe it, have fun with it. Next, the child wants to interact with it, touch it, feel it. From passive observations and active interactions, the child slowly learns about the world. Some interactions are fun: "If I tip the glass, I get to see the milk form pretty pictures on the floor." Others are not so much fun: "If I touch the red circles on the stove, my fingers hurt!" From each interaction, the child learns a little more about the world.

Like the child, scientists are exploring the unknown, and sometimes the known, features of the world. All basic research strategies are based on one simple notion: *To discover what the world is like, we must experience it.* To have an idea about the nature of the world is not enough. Instead, like the child, scientists experience the world to determine whether their ideas accurately reflect reality. Direct experience is an essential tool because it alone allows us to bridge the gap between our ideas and reality.

However, there is another aspect to science that many people do not think about. This is the aspect of *doubt.* One way in which we doubt is to question the common wisdom–whether it holds that the world is flat or that all our behavior is learned–and to seek different models of the world. Another way we use doubt is to question our research and ask whether other factors might have contributed to the results. As we will discuss throughout this book, science is more than just watching; it is rare that data actually speak for themselves.

In general, there is no single scientific method, any more than there is one art or one education or one religion, yet there is a general process called *science.* This process consists of experiencing the world and then drawing general conclusions (called *facts*) from observations. Sometimes these conclusions or facts are descriptive and can be represented by numbers. For example, we say that the moon is 238,000 miles from the earth or that the average human heart rate is 72 beats per minute. Other times these facts are more general and can describe a relationship or a process. For example, we say that it is more difficult to learn a second language after puberty than before or that as we age we hear fewer high-frequency sounds. Whatever the topic, the known facts about a particular subject are called *scientific knowledge.*

Much of our scientific knowledge is based on a history of research in a particular area. How we perform research is what this book is all about. Many conceptions of scientific research picture a man or a woman in a white lab coat, laboriously writing down numbers and later milling about in a cluttered office trying to make theoretical sense out of these findings. This conception may be partly accurate, but it is not a total picture of science. In this book, we stress another aspect of science, which becomes apparent when the available facts are viewed in light of human value. It is this aspect of value that allows us to see one set of numbers as more relevant or potentially more useful than another. This combining of fact and value results in a humanistic approach to scientific understanding. Scientific understanding helps us to see the *how* and *why* of the world and thereby to understand nature in a fuller perspective. In many cases, this understanding raises new questions, which in turn can be answered by using science to examine the world. In other cases, these new facts can be applied in real-life settings (technology) and make life easier for everyone. Thus, at its best, science begins and ends in human experience.

In the introduction to this book, we described three actors in the drama of science: the research participant, the scientist, and the witness. In our study of behavior and experience, it is the scientist who experiences the world and then formulates general facts or conclusions that describe it. The participant is the one who is studied in an experiment. In some cases, these roles are simple; in others, such as the study of human consciousness, the situation is more complex because we use our own consciousness to study consciousness. Finally, the witness provides the perspective, the concerns for value, and the relationship of science and its facts to other aspects of human life.

Science as a Way of Knowing

All of us at times fall into the trap of viewing science as the best way, or even the only way, to study behavior and experience. If you find this happening to you, beware! Although our culture emphasizes science as an important way of knowing, it is not the only way, and like all ways of knowing, it has certain limitations in its methods. To emphasize this, we offer science as merely one way of examining human nature. There are others; art, philosophy, religion, and literature are all fruitful ways or channels through which we can gain new ideas about human behavior and experience. Psychology has drawn on many of these traditions and will surely continue to do so.

Having a fruitful source of ideas, whether it is our literary, spiritual, scientific, or artistic traditions, is an important part of understanding behavior and experience. However, a second and perhaps even more important aspect of learning about psychology is the process of determining whether a new idea is accurate. In contrast to other ways of knowing, science offers not only a fertile source of new ideas but also a powerful method for evaluating the ideas we have about reality. For example, suppose someone tells you to buy a new exercise machine, or a well-known spiritual leader says that if you meditate twice a day you will be happier, or someone tells you that if you eat only a low-fat diet you will be healthier and live longer. These are instances in which you are confronted with new ideas that may have an important impact on your life. Because some time and effort are involved in these examples, and given the track record of some exercise specialists, spiritual teachers, and fad diets, you may be hesitant to change your habits unless you know it will be worthwhile. So you are faced with the task of evaluating the suggestions and deciding whether these ideas are right for you. How do you decide? In the remainder of this section, we examine several ways people decide whether to accept new ideas about the world. For a more detailed discussion of these ways of accepting belief, see the work of American philosopher Charles Peirce (Cohen & Nagel, 1934; Kerlinger, 1973, 1986). We are obviously biased and believe that the best way to respond to new ideas, especially for society at large, is to use science to evaluate these new ideas and then use the results of this research to help make a decision.

Tenacity

Peirce uses the term *tenacity* to refer to the acceptance of a belief based on the idea that "we have always known it to be this way." People at various times have said, "Women make bad soldiers," "You can't teach an old dog new tricks," or "Science is always beneficial." These statements are presented over and over again and accepted as true, yet they are rarely examined and evaluated. This is an all-too-common method of accepting information. Television advertising and political campaigns use this technique when they present a single phrase or slogan repeatedly. Even an empty phrase repeated often enough becomes accepted as true. As has been said, if you tell people something often enough, they will believe it.

As a way of learning about the world, there are two problems with this method. First, the statement may be just an empty phrase, and its accuracy may never have been evaluated. The statement may gain wide acceptance through its familiarity alone. Second, tenacity offers no means for correcting erroneous ideas. That is, once a belief is widely accepted solely on the basis of tenacity, it is difficult to change. Social psychologists have shown that once a person accepts a belief without data to support it, the person often will make up a reason for accepting the belief as true; the person may even refuse to accept new information that contradicts this belief. In the case of the diet example, a decision to begin a certain diet simply because it is said to be beneficial would be acceptance based on tenacity. Accepting ideas about experience and behavior simply because they are familiar to us or widely believed by others is an extension of the childish behavior of the 3-year-old who copies the words and behaviors of others. For the child this is an efficient beginning for learning about the world, but for the rest of us it is limiting.

Authority

A second way we may accept a new idea is when an authority figure tells us it is so. Acceptance based on authority is simple because we only have to repeat and live by what we are told. In many cases, referring to an authority, especially in areas about which we know nothing, is useful and beneficial. When we were young, our parents often used the method of authority for directing our behavior. In the past, health care and education were based almost exclusively on authority. If a famous physician or educator said something was true, almost everyone believed it to be true. Even today, we often rely on the judgment of an authority when we consult physicians, psychologists, scientists, or stockbrokers. Likewise, religious training often relies on the authority of religious leaders and elders for establishing correct religious procedures.

Although authority brings with it a stability that allows for consistency, it is not without problems. The major problem of accepting authority as having sole access to truth is that authority can be incorrect and thus send people in the wrong directions. For example, as long as everyone accepted the view that the earth was the center of the universe, no one thought to study the orbit of the earth. Consequently, it is important to examine the basis of the authority's claims. Are these claims based on opinion, tradition, revelation, or direct experience? How valid are the sources of this information? In the meditation example, if you decided to meditate simply because a well-known spiritual leader advised it, you would be basing your decision solely on the authority of this person. Box 1.1 discusses the transition from authority to experimentation in the beginning of modern science.

Box 1.1

Galileo: The Transition from Authority to Empiricism

For many scientists Galileo is a symbol of change in the rules of evidence. Of course, many people influenced the beginning of scientific thought during the Renaissance, beginning with Copernicus, Kepler, and the philosopher Bacon. However, Galileo and Newton (see Box 1.2) often are called the greatest founders of modern science (cf. Holton, 1952; Russell, 1984). Before their time, intellectual questions were answered by referring to authority, usually the authority of the church. The church of this period in turn looked to the Greek philosopher Aristotle for answers to "material" questions—what today we call natural science.

Suppose a person wanted to know which of two balls would hit the ground first if they were dropped from a tall building. Until the time of Galileo, the method of answering this question would be to refer to Aristotle's theory, which stated that the world is made up of four elements: earth, air, water, and fire. According to Aristotle, each element acts according to its own nature. To answer the question of which of two bodies would hit the ground first, one would reason that the two objects, composed of the element earth, would seek to return to earth and thus fall down. If one object weighed more than the other, it would be reasoned that this heavier object contained more of the element earth than the lighter one and would naturally fall faster. Thus, it would be concluded that the heavier body would hit the ground before the lighter one. No one would have thought to actually drop two objects from a tower and observe which hit the ground first. Answers were always given in terms of authority.

Galileo successfully replaced the method of authority with that of experimentation. This movement toward experimentation was greatly aided by Galileo's own inventions, such as the telescope, the thermometer, an improved microscope, and a pendulum-type timing device. Each of these instruments allowed people to experiment and answer for themselves the questions of nature. After establishing that balls rolling down an inclined plane act similarly to falling objects, Galileo successfully challenged the authority of Aristotle concerning two falling weights. With Galileo's work, a new science based on observation and experimentation was beginning. Galileo was part of a revolution that was to challenge authority. In fact, Einstein, in a later preface to Galileo's *Dialogues,* said that Galileo's main theme in his work was the "passionate fight against any kind of dogma based on authority." Although initially Galileo was well received in some quarters and even given life tenure in his professorship at the University of Padua, he later found himself at odds with the Church in Rome and spent the last 9 years of his life under house arrest near Florence.

Reason

Reason and logic are the basic methods of philosophy. Reason often takes the form of a logical syllogism, such as "All men can't count; Dick is a man; therefore, Dick can't count." We all use reason every day as we try to solve problems and understand relationships. As useful as it is to be reasonable, however, reason alone will not always produce the appropriate answer. Why? One potential problem in the reasoned approach is that our original assumption must be correct. If the original assumption is incorrect or at odds with the world in which we live, then logic cannot help us. For example, the syllogism that concluded that Dick can't count is logically valid even though it is based on the absurd premise that all men can't count. The weakness of using reason alone is that we have no way to determine the accuracy of our assumptions. Thus, we can have situations in which our logic is impeccable, but because our original assumption is inaccurate, the conclusion is silly.

Common Sense

Common sense offers an improvement over acceptance based on tenacity, authority, or reason because it appeals to direct experience. Common sense is based on our own past experiences and our perceptions of the world. However, our experiences and perceptions of the world may be quite limited. The optical illusions that you probably studied in introductory psychology gave you a clear example of how our perceptions can lead us to incorrect conclusions. There can also be a bias in the way we think. Piattelli-Palmarini (1994) suggests that just as there are optical illusions, there are also cognitive illusions that lead us to be certain but wrong in our answers. Furthermore, research in social psychology has shown that we make different psychological attributions depending on whether we observe or participate in a given situation. If we are asked to explain why someone made a bad grade, we tend to make internal attributions, such as, "She didn't study" or "He isn't smart." However, if we received a bad grade on a test, we would tend to make external attributions, such as, "I had three tests that day" or "The test was unfair."

Whereas common sense may help us deal with the routine aspects of daily life, it may also form a wall and prevent us from understanding new areas. This can be a problem, particularly when we enter realms outside our everyday experience. For example, people considered Albert Einstein's suggestion that time was relative and could be different for different people to be against common sense. Likewise, it was considered against common sense when Sigmund Freud suggested that we did not always know our own motivations or when B. F. Skinner suggested that the concept of free will was inapplicable to the behavior of most individuals. We might also assume that the stable process is the more healthy one. However, recent research using nonlinear (chaos) analysis has suggested, for example, that the patterns of a healthy heart are erratic and those of a pathological heart can be regular (Goldberger & Rigney, 1991).

Science

We end our discussion of the ways people accept new ideas by discussing science. Philosopher of science Alfred North Whitehead (1925) suggested that there are two methods for what he called the "purification of ideas" and that these methods are combined in the scientific method. An idea is evaluated or corrected through (1) dispassionately observing by means of our bodily senses (for example, vision, hearing, and touch) and (2) using reason to compare various theoretical conceptualizations based on experience.

The first method is a direct extension of the common-sense approach just described. Unlike a given person's common sense, however, science is open to *anyone's* direct experience. Presumably, any observation made by one scientist could be verified by any other person with normal sensory capacities. To aid people in repeating the observations of others, some scientists (see Bridgman, 1927) have emphasized the importance of *operational definitions* in research. As you will see in Chapter 2, operational definitions direct *how* observations are to be made and what is to be observed and measured.

The second method is a direct application of the principles of logic. In this case, however, logic is combined with experience to rule out any assumptions that do not accurately reflect the scientific experiment. This blend of direct sensory experience and reason gives science a self-corrective nature that is not found in other ways of accepting ideas about the world. One important technique is replication, in which a procedure is repeated under similar conditions. For example, if an experiment is found to give similar results in different labs and even in different parts of the world, this lends support to the conclusions. This means that scientific conclusions are never taken as final but are always open to reinterpretation as new evidence becomes available. In other words, the method of science includes a feedback component by which conclusions about the world can be refined over time. It is the refining of ideas through both experimentation and reason that allows science to be a fruitful method for knowing about the world.

Historically, the methods of modern science can be traced to the 17th century. The work of Sir Isaac Newton generally is credited as representing the beginning of modern science. Box 1.2 describes Newton's rules of reasoning in science. These rules form the basis of the modern scientific approach: the law of parsimony, the assumption that there exists a unity to the physical universe in which we live, the possibility of generalizing from experiments, and the acceptance of empirical data over opinion. In many ways these rules are as applicable today as they were when they were written more than 300 years ago.

The Scientific Approach

In this chapter we examine the scientific approach through various informal illustrations, examples, and stories. In Chapter 2 we discuss more formally the methods of natural observation and experimentation. Among other things, we emphasize that a major characteristic of science is a reliance on information that is *verifiable through experience.* That is, it must be possible for different people in different places and at different times using a similar method to produce the same results.

Box 1.2

Newton's Rules of Reasoning

Born the year after Galileo's death, Newton produced a body of work that represents the beginning of modern science as we know it. Whereas Galileo fought with philosophers of his day and was persecuted by the Church for his beliefs, Newton lived in a new age in which science through experimentation and reason began to bear fruit.

In the 1680s, Newton's classic work *Principia* was published (Newton, 1969 reprint). Designated by science historian Gerald Holton (1952) as "probably the greatest single book in the history of science," this work describes Newton's theories of time, space, and motion as well as his rules of reasoning for science. Science, called natural philosophy by Newton, is based on four rules of reasoning.

Rule 1

We are to admit no more causes of natural things than such as are both true and sufficient to explain their appearances.

To this purpose the philosophers say that Nature does nothing in vain, and more is in vain when less will serve; for Nature is pleased with simplicity, and affects not the pomp of superfluous causes.

Today we call this rule the law of parsimony. The rule simply states that natural events should be explained in the simplest way possible.

Rule 2

Therefore to the same natural effects we must, as far as possible, assign the same causes.

As to respiration in a man and in a beast, the descent of stones in Europe and in America; the light of our culinary fire and of the sun; the reflection of light in the earth, and in the planets.

This rule reflects Newton's belief in a natural order, which requires that the same gravity causes stones to fall in Europe and in America.

Rule 3

The qualities of bodies, which admit neither intensification nor remission of degrees, and which are found to belong to all bodies within

Once you know the methods of science and have used them in a variety of situations, you will be in a position to evaluate science as a method of knowing about the world that includes the behavior and experience of yourself and others. More important, you will be in a position to decide whether science is the way you choose to understand the world. First, however, let us begin to understand what science is by looking at three early efforts to understand the world. Although these efforts attempted to be systematic, today we would call them preexperimental or quasiexperimental. That is, in none of these procedures was an actual experiment conducted. Our purpose is to focus on the manner in which the problem was solved–particularly the efforts to be systematic–and what errors were made. You might also recall instances from your own life when you attempted to solve problems in similar ways.