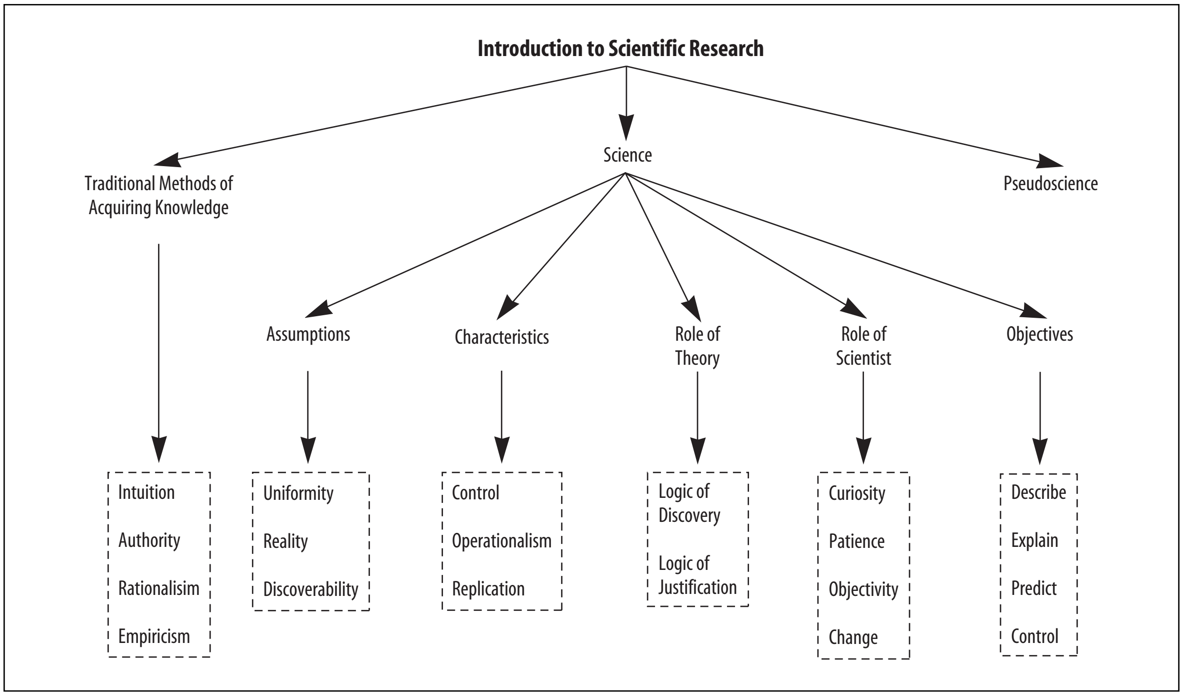
Part I Introduction

CHAPTER 1

Introduction to Scientific Research



On July 5, 1998, the *Los Angeles Daily News* ran an article under the headline "Handwriting Analyst Reads Human Nature." In this article, Sheila Lowe, a handwriting analyst for 31 years, stated that "you are what you write." According to Ms. Lowe, handwriting always tells the truth because it is a projective behavior that reflects all the experiences of a person's life. Lowe has gained considerable attention for her comments to the media on criminal and civil trials such as the O. J. Simpson trial and the JonBenet Ramsey murder case. She has even appeared on NBC's *Unsolved*

Mysteries. She states that when she analyzes handwriting, she tries to focus on small details, such as how Ts are crossed, as well as the larger picture, such as the arrangement and balance on the page and whether anything stands out. From a handwriting analysis of individuals such as former president Bill Clinton and Elvis Presley, she drew the following conclusions. "Bill Clinton is a combination of strength and flexibility. He can stand firm and build a consensus." Elvis Presley's handwriting indicated that he was in ill-health and depressed.

Is there anything to handwriting analysis? Are you what you write, as claimed by Ms. Lowe? It would be wonderful if we could tell what a person was like just from analyzing a sample of an individual's handwriting. There are, however, many skeptics of handwriting analysis. Handwriting analysis has typically been criticized by scientists as something akin to fortune-telling and palm reading. In spite of this, some individuals and companies are turning to individuals such as Ms. Lowe to assist them in identifying desirable employees and in providing guidance in child rearing. Law enforcement agencies have employed her to assist in background investigations, as have individuals involved in romantic entanglements. Ms. Lowe has even sold a computer program that analyzes handwriting because of the demand for her services.

There seems to be little question that there is an interest in handwriting analysis. The important question is whether handwriting analysis really does provide a window into the personality of an individual. Obviously many individuals think it does because they use it in making some very important decisions. But how do we know for sure? In order to determine if handwriting analysis can provide an accurate and reliable assessment of personality, we must conduct a scientific study. You might wonder how something that seems as subjective as handwriting analysis can be scientifically investigated. Many people do not understand the nature of a scientific investigation or the need to conduct such an investigation in situations like this. This lack of understanding might be because scientists are often conceptualized as people in white coats who work in a laboratory, conducting experiments on complex theories that are far beyond the comprehension of the average person. Actually studying the validity of something like handwriting analysis seems very mysterious. This is probably because the actual process by which scientists uncover the mysteries of the universe eludes many people. It is as if the research process were encompassed in a shroud of secrecy and could be revealed only to the scientist. Research, however, is not a mysterious phenomenon! Rather, it is a very logical, creative, and rigorous set of methods for obtaining facts and making warranted generalizations.

Introduction

In our daily lives, we continually encounter problems and questions relating to thoughts and behavior. For example, one person might have a tremendous fear of taking tests. Others might have problems with alcoholism or drug abuse or problems in their marriage. People who encounter such problems typically want to eliminate them, but often need help. Consequently, they seek out professionals, such as psychologists, to help them remediate such difficulties. Likewise, business professionals might enlist the assistance of psychologists in understanding the thinking and behavior of others. For example, salespeople differ greatly in their ability to understand customers and sell merchandise. One car salesperson might be capable of selling twice as many cars as another salesperson. If the sales manager could discover why such differences in ability exist, he or she might be able to develop either better training programs or more effective criteria for selecting the sales force.

In an attempt to gain information about mental processes and behavior, people turn to the field of psychology. As you should know by now, a great deal of knowledge about information processing and the behavior of multiple types of organisms has been accumulated. We have knowledge that enables us to treat problems such as test anxiety and depression. Similarly, we have identified many of the variables influencing persuasion and aggression. Although we know a great deal about mental processes and behavior, there is still much to be learned. In order to learn more about such psychological phenomena, we must engage in scientific research.

The course in which you are now enrolled will provide you with information about conducting scientific research. Some students might feel that understanding research is important only for professional scientists. But, as Table 1.1 reveals, there are many reasons why students should take a research methods course. One reason identified in Table 1.1 is to help students become more informed and critical consumers of information. We are all bombarded by the results of scientific and pseudoscientific research, and we all need tools to interpret what is being reported. For example, saccharin has been demonstrated to cause cancer in laboratory animals, yet there are many people who consume saccharin and do not contract cancer. You as a consumer must be able to resolve these discrepancies in order to decide whether or not you are going to eat foods containing saccharin. Similarly, television commercials often make claims of "scientific proof" regarding the effectiveness of their products. First of all, science does not provide "proof" for general laws; instead, it provides evidence, often very strong evidence. Second, upon closer examination, almost all of the "scientific tests" reported in television commercials would likely be shown to be flawed.

TABLE 1.1

Reasons for Taking a Research Methods Course

- Learn how to conduct psychological research.
- Provides a foundation for topic-specific courses such as abnormal, social, cognitive, biopsychology, and developmental psychology.
- Can be a more informed and critical consumer of information.
- Helps develop critical and analytical thinking.
- Provides information needed to critically read a research article.
- Necessary for admission into most graduate programs in psychology.

Methods of Acquiring Knowledge

There are many procedures by which we obtain information about a given phenomenon or situation. We acquire a great deal of information from the events we experience as we go through life. Experts also provide us with much information. We will briefly discuss four ways by which we acquire knowledge, and then we will discuss the scientific approach to acquiring knowledge. You should be able to see that each successive approach represents a more acceptable means of acquiring knowledge. You will also see that although the earlier approaches do not systematically contribute to the accumulation of scientific knowledge, they are used in the scientific process. The scientific approach is a very special hybrid approach to generating and justifying knowledge claims and to accumulating this knowledge over time.

Intuition

Intuition
An approach to acquiring knowledge that is not based on a known reasoning process

Intuition is the first approach to acquiring knowledge that we examine. *Webster's Third New International Dictionary* defines intuition as "the act or process of coming to direct knowledge or certainty without reasoning or inferring." Such psychics as Edgar Cayce seem to have derived their knowledge from intuition. The predictions and descriptions made by psychics are not based on any known reasoning or inferring process; therefore, such knowledge would appear to be intuitive. Intuition relies on justification such as "it feels true to me" or "I believe this point, although I can't really tell you why." The problem with the intuitive approach is that it does not provide a mechanism for separating accurate from inaccurate knowledge.

The use of intuition is sometimes used in science (Polanyi & Sen, 2009), and it is probably seen most readily in the process of forming hypotheses. Although most scientific hypotheses are derived from prior research, some hypotheses arise from hunches and new ways of looking at the literature. You might, for example, think that women are better at assessing the quality of a relationship than are men. This belief might have been derived from things others told you, your own experience, or any of a variety of other factors. Somehow you put together prior experience and other sources of information to arrive at this belief. If someone asked you why you held this belief, you probably could not identify the relevant factors—you might instead say it was based on your intuition. From a scientific perspective, this intuition could be molded into a hypothesis and tested. A scientific research study could be designed to determine whether women are better at assessing the quality of a relationship than are men.

Authority

Authority
A basis for acceptance of information, because it is acquired from a highly respected source

Authority as an approach to acquiring knowledge represents an acceptance of information or facts stated by another because that person is a highly respected source. For example, on July 4, 1936, the Central Committee of the Communist Party of the Soviet Union issued a "Decree Against Pedology" (Woodworth & Sheehan, 1964), which, among other things, outlawed the use of standardized tests in schools. Because no one had the right to question such a decree, the need to eliminate standardized tests had to be accepted as fact. The problem with the authority approach is that the information or facts stated by the authority might be inaccurate.

If the authority approach dictates that we accept whatever is decreed, how can this approach be used in science? In the beginning stages of the research process, when the problem is being identified and the hypothesis is being formed, a scientist might consult someone who is considered "the" authority in the area to assess the probability that the hypothesis is one that is testable and addresses an important research question. Virtually every area of endeavor has a leading proponent who is considered the authority or expert on a given topic. This is the person who has the most information on a given topic.

Although authority plays a part in the development of hypotheses, it is not without its problems. A person who is perceived as an authority can be incorrect. For example, Key (1980) has been a major proponent of the claim that advertisers resort to "subliminal advertising" to influence public buying and has been perceived by some as being the authority on this topic. He has stated, for instance, that implicitly sexual associations in advertisements enhance memorability. Fortunately, such claims by authority figures are subject to assessment by research studies. The claims made by Key (1980) are readily testable and were tested by Vokey and Read (1985) in their study of subliminal messages. Vokey and Read demonstrated that Key's claims were unfounded.

Authority is also used in the design stage of a study. If you are unsure of how to design a study to test a specific variable, you might call someone who is considered an authority in the area and get his or her input. Similarly, if you have collected data on a given topic and you are not sure how to interpret the data or how they fit with the other data in the field, you might consult with someone who is considered an authority in the area and obtain input. As you can see, the authority approach is used in research. However, an authority is an expert whose facts and information are subject to testing using the scientific process.

Rationalism

Rationalism
The acquisition of knowledge through reasoning

A third approach to gaining knowledge is **rationalism**. This approach uses reasoning to arrive at knowledge and assumes that valid knowledge is acquired if the correct reasoning process is used. During the sixteenth century, rationalism was assumed to be the dominant mode by which one could arrive at truth. In fact, it was believed that knowledge derived from reason was just as valid as, and often superior to, knowledge gained from observation. Its leading advocate was the philosopher René Descartes (1596–1650). Descartes, who famously claimed, "I think, therefore I am", argued that "clear and distinct ideas" must be true, and from those foundational ideas one should deduce all other beliefs. One danger of relying solely on rationalism for acquiring knowledge is that it is not unusual for two well-meaning and honest individuals to reach different conclusions.

This does not mean that science does not use reasoning or rationalism. In fact, reasoning is a vital element in the scientific process. Scientists make use of reasoning not only to derive some hypotheses but also to identify the outcomes that would indicate the truth or falsity of the hypotheses. Mathematics, which is a type of rationalism, is used extensively in many areas of science such as physics. There is also a well-developed line of research in mathematical psychology. In short, rationalism can be very important for science, but by itself it is insufficient.

Empiricism

Empiricism The acquisition of knowledge through experience

A fourth approach to gaining knowledge is through **empiricism**. In its naïve form, this approach would say, "If I have experienced something, then it is valid and true." Therefore, facts that concur with experience are accepted, and those that do not are rejected. This approach was used by some individuals in the 1960s who stated that satanic messages were included on some records. These individuals had played the records backward and had heard messages such as "Oh Satan, move in our voices." Because these individuals had actually listened to the records and heard the messages, this information seemed to be irrefutable. Therefore, naïve empiricism can be problematic; however, empiricism in its more realistic form can be very useful, and, as you will see, it is an important part of the scientific approach.

Empiricism as a systematic and well-developed philosophy is traced to John Locke (1632–1704) and David Hume (1711–1776). These philosophers argued that virtually all knowledge is based on experience. Locke put it well when he claimed that each person is born a *tabula rasa* (i.e., individuals' minds are blank slates or tablets upon which the environment or nature writes). The *origin* of all knowledge is from our senses (sight, hearing, touch, smell, and taste). Our senses imprint ideas in our brains that then are further worked upon (combined, related) through cognitive processes. The early system of psychology known as associationism arose out of empiricist philosophy, and one might view it as the first "school of psychology" (Heidbreder, 1933). Although the empirical approach is very appealing and has much to recommend it, several dangers exist if it is used alone. Our perceptions are affected by a number of variables. Research has demonstrated that such variables as past experiences and our motivations at the time of perceiving can drastically alter what we see. Research has also revealed that our memory for events does not remain constant. Not only do we tend to forget things, but at times an actual distortion of memory might take place.

Empiricism is probably the most obvious approach that is used in science. Science is based on observation, and empiricism refers to the observation of a given phenomenon. The scientific studies investigating the satanic messages that supposedly existed when certain records were played backward made use of the same empirical observations as did the unscientific approach. Greenwald (mentioned in Vokey & Read, 1985), for example, played records backward and asked people to hear for themselves the satanic messages that appeared on the records. In doing so, Greenwald relied on empiricism to convince the listeners that satanic messages were actually on the records. Scientific studies such as those conducted by Vokey and Read (1985) and Thorne and Himelstein (1984) make use of the same type of data. These studies also ask people to identify what they hear on records played backward. The difference is the degree of objectivity that is systematically imposed on the observation. Greenwald proposed to the listeners that the source of the messages was Satan or an evil-minded producer, thereby generating an expectation of the type of message that might exist on the records. In science, researchers avoid setting up such an expectation unless the purpose of the study is to test such an expectation. Vokey and Read (1985), for example, used religious as well as meaningless passages played backward and asked participants to try to identify messages. These research participants were not, however, informed of the probable source of the messages. Interestingly, Vokey and Read discovered that messages were identified in both meaningless and religious passages played backward, and subjects found that some of these messages had satanic suggestions.

Empiricism is a vital element in science, but in science, empirical observations must be conducted under controlled conditions and systematic strategies must be used to minimize researcher bias and to maximize objectivity. The later chapters in this book will carefully explain how to carry out empirical research that is scientific and, therefore, reliable and trustworthy.

STUDY QUESTION 1.1 **Explain each of the approaches to acquiring knowledge and how these methods are used in science.**

Science

Science The most trustworthy way of acquiring reliable and valid knowledge about the natural world

The word *science* had its ancient origins in the Latin verb *scire*, meaning "to know." However, the English word "science," with its current meaning, was not coined until the nineteenth century by William Whewell (1794–1866). Before that time, scientists were called "natural philosophers" (Yeo, 2003). **Science** is a very important way of acquiring knowledge. Although it is a hybrid of the forms discussed earlier, it is superior in the sense that it is designed to systematically produce reliable and valid knowledge about the natural world. One might think that there is only one method by which scientific knowledge is acquired. While this is a logical thought, Proctor and Capaldi (2001) have pointed out that different scientific methods have been popular at different points in time. That's because science continues to develop and improve all the time. We now take a brief historical tour of scientific methods.

Induction and Deduction

Induction A reasoning process that involves going from the specific to the general

As classically defined by Aristotle (384–322 BCE), **induction** is a reasoning process that involves going from the specific to the general.[1] For example, if on a visit to a daycare center you see several children hitting and kicking other children, you might infer that many children in that center are aggressive or even infer that children in daycare centers across the country tend to be aggressive. This inference is

[1]In the philosophy of logic, induction and deduction have slightly different meanings from what is presented here. In philosophy of logic, inductive reasoning refers to drawing of a conclusion that is probably true, and valid deductive reasoning refers to the drawing of a conclusion that is necessarily true if the premises are true (Copi & Cohen, 2005).

an example of induction, because you moved from the particular observations to a much broader and general claim. Induction was the dominant scientific method used from the late seventeenth century to about the middle of the nineteenth century (Proctor & Capaldi, 2001). It was during this time that scientific advances were made by careful observation of phenomena with the intent to arrive at correct generalizations. Both Francis Bacon (1561–1626) and Isaac Newton (1642–1727) advocated this approach. Newton, for example, has stated that "principles deduced from phenomena and made general by induction, *represent* (italics ours) the highest evidence that a proposition can have . . . " (Thayer, 1953, p. 6).

While induction is not the primary scientific method used today, it is still used very frequently in science. For example, Latané (1981) observed that people do not exert as much effort in a group as they do when working alone and inferred that this represented the construct of social loafing. When Latané made this generalization of social loafing from the specific observation that less effort was expended in a group, he was engaged in inductive reasoning. Inductive reasoning is also seen in the use of statistical analysis in psychological research. When researchers rely on samples and generalize to populations, they are using inductive reasoning. Inductive reasoning is, therefore, an integral part of science. It is not, however, the only reasoning process used in science. Deductive reasoning is also used.

Deduction
A reasoning process that involves going from the general to the specific

Deduction, as classically defined by Aristotle, refers to going from the general to the specific. For example, Levine (2000) predicted that a person who views the group's task as important and does not expect others to contribute adequately to the group's performance will work harder. Here, Levine was logically moving from the general proposition of social loafing and deducing a specific set of events that would reduce social loafing. Specifically, Levine deduced that viewing the group's task as important and not expecting others to contribute adequately would cause a person to work harder or counter the social loafing effect. Today, when researchers develop hypotheses, they routinely deduce the observable consequences that must occur if they are going to claim (after collecting data) that the hypothesis is supported or not supported. As mentioned earlier, deduction is also routinely used in mathematical psychology.

Science, therefore, makes use of *both* inductive and deductive thinking. However, neither of these approaches represents the only or primary approach to current science.

Hypothesis Testing

Hypothesis testing
The process of testing a predicted relationship or hypothesis by making observations and then comparing the observed facts with the hypothesis or predicted relationship

Hypothesis testing refers to a process by which an investigator formulates a hypothesis to explain some phenomenon that has been observed and then compares the hypothesis with the facts. Around 1850, induction was considered to be inadequate for the task of creating good scientific theories. Scientists and philosophers suggested that hypothesis testing should be formally added to induction as the appropriate scientific method (Proctor & Capaldi, 2001). According to Whewell (1847/1967), "The process of scientific discovery is cautious and rigorous, not by abstaining from hypothesis, but by rigorously comparing hypothesis with facts, and by resolutely rejecting all which the comparison does not confirm" (p. 468). According to this approach, scientific activity involves the testing of hypotheses derived from theory or experience. Whewell suggested that science should focus on the confirmation of predictions derived from theory and experience.

Proctor and Capaldi (2001) argue that the era of hypothesis testing extended from approximately 1850 to about 1960. However, an examination of the psychological research literature shows that hypothesis testing has been, and still is, a very important part of scientific activity in psychology. For example, Fuller, Luck, McMahon, and Gold (2005) investigated cognitive impairments in schizophrenic patients. They hypothesized that schizophrenics' working memory representation would be abnormally fragile, making them prone to being disrupted by distracting stimuli. They then designed a study to collect data that would test the adequacy of this hypothesis.

Logical positivism A philosophical approach that focused on verifying hypotheses as the key criterion of science

Hypothesis testing as a scientific methodology was associated with the logical positivist movement. **Logical positivism** was the outgrowth of a group of scholars at the University of Vienna with a scientific background and a philosophical bent. This group became known as the Vienna Circle and espoused a logical positivism philosophical position (Miller, 1999). One of the central views of the Vienna Circle was that a statement is meaningful only when it is verifiable by observation or experience. Logical positivists believed that the most important aspect of science was the verification of hypotheses by objective observation or experience. Logical positivist Moritz Schlick (1882–1936) said in 1934 "Science makes prophecies that are tested by 'experience' " (in Ayer, 1959, p. 221). For the logical positivists, hypothesis testing was an inductive approach that moved from experiential "facts" (i.e., from particulars) to general propositions. They ultimately hoped to show that the natural world followed scientific laws.

Although logical positivism had many supporters, it was also criticized. One of the most severe critics was the philosopher of science Karl Popper (1902–1994). Popper pointed out that the (inductive) verification approach of the logical positivists was based on a logical fallacy (known as affirming the consequent). To fix this "error," Popper argued that science should rest on a deductively valid form of reasoning (1968). One can claim conclusively using deductive reasoning that a general law is falsified if the data do not support the hypothesis, and this deductively valid approach is what Popper advocated. He argued that science should focus on stating bold hypotheses followed by attempts to falsify them. Popper's approach is known as **falsificationism**.

Falsificationism A deductive approach to science that focuses on falsifying hypotheses as the key criterion of science

A major strength of Popper's approach is that it helps eliminate false theories from science. However, Popper's approach also was criticized because it focused *only* on falsification and completely rejected induction. Popper stated "There is no induction; we never argue from facts to theories, unless by way of refutation or 'falsification' " (Popper, 1974, p. 68). Unfortunately for Popper, induction is required in order to claim what theories are supported and what theories we should believe. Popper's approach was also criticized because even if the data appear to falsify a hypothesis, one still cannot conclude that the theory is necessarily false. That's because many assumptions have to be made during the hypothesis testing process, and one of those assumptions might have been false rather than the hypothesis. This idea that a hypothesis cannot be tested in

Duhem–Quine principle
States that a hypothesis cannot be tested in isolation from other assumptions

isolation (i.e., without making additional assumptions) is called the **Duhem–Quine principle**. Today, psychologists rely on a hybrid approach to hypothesis testing that includes probabilistic thinking, preponderance of evidence, and a mixture of the logical positivists' verification approach *and* Popper's falsification approach. It is important to remember that hypothesis testing produces evidence but does not provide proof of psychological principles.

Naturalism

Since the 1960s we have entered a methodological era in science that has evolved from a movement in the philosophy of science called naturalism (Proctor & Capaldi, 2001). Naturalism rejects what is called *foundational epistemology*, which assumes that knowledge is a matter of deductive reasoning and that knowledge is fully certain, much like a mathematical or geometrical proof. Instead, **naturalism** takes the position that science should be studied and evaluated empirically, just like a science studies any other empirical phenomenon. Naturalism is a *pragmatic* philosophy of science that says scientists should believe what is shown to work. When it comes to judging scientific beliefs, naturalism says we should evaluate our theories based on their **empirical adequacy**. That is, do the empirical data support the theory, does the theory make accurate predictions, and does the theory provide a good causal explanation of the phenomenon that you are studying?

Naturalism
Position popular in behavioral science stating that science should justify its practices according to how well they work rather than according to philosophical arguments

Empirical adequacy
Present when theories and hypotheses closely fit empirical evidence

If you look at the history of science, you can see that scientific advances exhibit a structure that is not captured singularly by hypothesis testing or induction. Science uses many approaches that have been shown to be helpful to the advancement of valid and reliable knowledge. Naturalism takes a practical approach to methods and strategies. Next we briefly mention several historical influences since about 1960 that were precursors to today's scientific naturalism.

Normal science
The period in which scientific activity is governed and directed by a single paradigm

Paradigm
A framework of thought or beliefs by which reality is interpreted

Revolutionary science
A period in which scientific activity is characterized by the replacement of one paradigm with another

Kuhn and Paradigms Thomas Kuhn (1922–1996) conducted a historical analysis of science and, in 1962, published his famous book *The Structure of Scientific Revolutions*. His research suggested that science reflects two types of activities: normal science and revolutionary science. **Normal science** is governed by a single paradigm or a set of concepts, values, perceptions, and practices shared by a community that forms a particular view of reality. A **paradigm**, therefore, is a framework of thought or beliefs by which you interpret reality. Mature sciences spend most of their time in "normal science." However, over time anomalies and criticisms develop, and **revolutionary science** occurs. During this more brief period (compared to normal science), the old paradigm is replaced by a new paradigm. Replacement of one paradigm with another is a significant event because the belief system that governs the current view of reality is replaced with a new set of beliefs. After a revolutionary period, science enters a new period of normal science, and this process, according to Kuhn, has continued throughout history.

Lakatos and Research Programs Another philosopher of science named Imre Lakatos (1922–1974) took an approach similar to that of Kuhn by attempting to

Research program Lakatos's term for a paradigm. It includes a set of "hard-core" beliefs and an outer "protective belt" of additional beliefs

portray scientific activity as taking place within a framework. Kuhn labeled this framework a paradigm, but Lakatos coined the phrase **research program** to represent this framework (Lakatos, 1970). According to Lakatos, a research program involves a succession of theories that are linked by a set of *hard-core* beliefs; this is in contrast to Kuhn who saw each paradigm being replaced by an entirely new paradigm. For example, one of the core principles of the Copernican program was that the earth and the planets orbit a stationary sun. Lakatos's hard-core beliefs or principles are the defining characteristics of a research program, but a research program also includes a *protective belt* of additional beliefs, principles, assumptions, and so on. Lakatos argued that scientists would not allow the hard-core principles to be falsified as Popper had assumed; Lakatos argued that when a hard-core hypothesis is not supported, the researcher would simply modify something in the protective belt. This certainly makes it very difficult for a theory to be falsified or rejected.

A development within the field of psychology of learning provides an example of what Kuhn would have called paradigms and Lakatos would have called research programs. In the early 1930s, a "mechanistic" paradigm or research program had developed in the psychology of learning. The basic set of concepts and beliefs or the fundamental principle of this mechanistic view was that learning is achieved through the conditioning and extinction of specific stimulus–response pairs. The organism is reactive in that learning occurs as a result of the application of an external force known as a reinforcer.

A competing paradigm at this time was an "organismic" paradigm or research program. The basic set of concepts and beliefs or the fundamental principles of the organismic view were that learning is achieved through the testing of rules or hypotheses and organisms are active rather than reactive. Change or learning occurs by some internal transformation such as would be advocated by Gestalt theory, information processing, or cognitive psychology (Gholson & Barker, 1985). Piaget's theory of child development is an example of the organismic view. Other paradigms, research programs, or research traditions (Laudan, 1977) in psychology include associationism, behaviorism, cognitive psychology, and neuropsychology.

Feyerabend's Anarchistic Theory of Science Paul Feyerabend (1924–1994) was a philosopher of science who looked at the various methodological approaches to science that had been advocated and was not surprised to see that each had been criticized and was lacking. For example, both the verification approach advocated by the logical positivists and the falsification approach advocated by Popper floundered because of the logical problems mentioned earlier. As a result of the failure to identify any single distinguishing characteristic of science, Feyerabend (1975) argued that there is no such thing as the method of science. According to him, science has many methods. Most psychologists would argue, however, that Feyerabend went too far when he claimed that the single unchanging principle of scientific method is that "anything goes." Feyerabend also argued that science included many irrational practices and was partially the result of the operation of power. He concluded that scientific knowledge was not nearly as secure as scientists would have the public believe. As you can see, Feyerabend offered a relatively severe critique of normal science. Perhaps the key conclusion to draw from his critique is that science might not be as simple and formulaic as it sometimes is made to appear. In short, it is true that scientific practice includes many complexities. Nonetheless, in this book, we will do our best to explain some of the complexities and provide a clear explanation of the current best practices in psychological research.

What Exactly Is Science?

Philosophers have, for many years, been trying to provide an exact demarcation of science from nonscience. The logical positivists had hoped verificationism would be the criterion. They also hoped a single, universal method could be identified. Popper claimed the criterion was falsificationism (i.e., only scientists attempted to falsify hypotheses). For Kuhn, it was the values, interactions, and activities of scientists that identified science. Some philosophers of science seek a relatively secure basis for science in experimentation or what Robert Ackermann (1989) calls "the new experimentalism." According to this approach, experimentation can have a life of its own independent of theory, and scientific progress is seen as the steady buildup of experimental knowledge (Chalmers, 1999) or knowledge acquired from experimentation. In many ways, the experiment is the strongest and best of the scientific methods. It is probably better to conclude, however, that the multiple methods and practices used by the many highly trained scientists can contribute in complementary ways to the development of secure scientific knowledge.

As you can see, there is no perfect definition of science that applies to every part of every field in science (e.g., physics, psychology, or molecular biology). Science just does not seem to run according to a *single* set of fixed and universal rules or activities. Identifying a single rule or activity probably would be detrimental to science because it would neglect the complex character of science; it also would make it less adaptable and more dogmatic. Still, one needs a working definition of science. According to Chalmers, "a science will consist of some specific aims to arrive at knowledge of some specific kind, methods for arriving at those aims together with the standards for judging the extent to which they have been met, and specific facts and theories that represent the current state of play as far as the realization of the aim is concerned" (Chalmers, 1999, p. 168). This is consistent with our view of science as the preferred way of acquiring reliable, valid, and practical knowledge about the natural world, but to continue to be successful, it must always practice research ethically, must critically self-examine its practices to determine what is working and what is not working, and must engage in ongoing learning and improvement. If science does this, scientific knowledge also will continue to advance.

STUDY QUESTIONS 1.2

- **What is science, and how have the methods of science changed over time?**
- **What is the difference between induction and deduction?**
- **What is naturalism?**
- **What are the similarities between Kuhn's and Lakatos's approach to science?**
- **Why has Feyerabend argued that there is no such thing as a method of science?**

Basic Assumptions Underlying Scientific Research

In order for scientists to have confidence in the capacity of scientific research to achieve solutions to questions and problems, they make several working assumptions so that they can get on with the day-to-day practice of science.

Uniformity or Regularity in Nature

Determinism
The belief that mental processes and behaviors are fully caused by prior natural factors

Probabilistic causes
A weaker form of determinism that indicates regularities that usually but not always occur

Science searches for regularities in nature. If there were no uniformity or regularity, science would only amount to a historical description of unrelated facts. B. F. Skinner (1904–1990) put it well when he stated that science is "a search for order, for uniformities, for lawful relations among the events in nature" (1953, p. 13). If there were no uniformity in nature, there could be no understanding, explanation, or knowledge about nature. Without regularity, we could not develop theories or laws or generalizations. Implicit in the assumption of uniformity is the notion of a rather strong form of **determinism**—the belief that there are causes, or determinants, of mental processes and behavior. In our efforts to uncover the laws of psychology, we attempt to identify the variables that are linked together. What we have found thus far are **probabilistic causes** (i.e., causes that usually produce outcomes), but the search for more certain, fuller causation will continue. We construct experiments that attempt to establish the determinants of events. Once we have determined the events or conditions that usually produce a given outcome, we have uncovered probabilistic causes.

Reality in Nature

Reality in nature
The assumption that the things we see, hear, feel, smell, and taste are real

A related assumption is that there is **reality in nature**. For example, as we go through our daily lives we see, hear, feel, smell, and taste things that are real, and these experiences are real. We assume that other people, objects, or social events like marriage or divorce are not *just* creations of our imagination, and we assume that many different types of "objects" can be studied scientifically. Stating that something is true or real because we say it is real does not work in science. In science, researchers check the reality in many ways to obtain objective evidence that what is claimed is actually true. In short, researchers interact with a natural world (that includes social objects such as attitudes, beliefs, institutions), and this reality must have primary say in our claims about reality and truth. This is why we collect data. Again, science makes the assumption that there is an underlying reality, and it attempts to uncover this reality.

Discoverability

Discoverability
The assumption that it is possible to discover the regularities that exist in nature

Scientists believe not only that there is regularity and reality in nature but also that there is **discoverability**—that is, it is possible to discover the regularities and reality. This does not mean that the task of discovering the regularities will be simple. Nature is very reluctant to reveal its secrets. Scientists have been working on discovering the cause and cure for cancer for decades. Although significant progress has been made, we still do not know the exact cause of all forms of cancer or the contributors to the development of cancer. Similarly, a complete cure for cancer still does not exist. An intensive effort is also taking place within the scientific community to identify a cure for AIDS. However, scientists have yet to fully uncover nature's secrets in this arena.

The intensive effort that has existed to uncover the cause of such diseases as cancer and AIDS or, within the field of psychology, such disorders as schizophrenia and depression reveals one of the basic processes of research. The research process is similar to putting a puzzle together: You have all the pieces of the puzzle in front of you, which you try to put together to get the overall picture. Scientific research includes the difficult task of first discovering the pieces of the puzzle. Each study conducted on a given problem has the potential of uncovering a piece of the puzzle. Only when each of these pieces has been discovered is it possible for someone to put them together to enable us to see the total picture. Consequently, discoverability incorporates two components: The first is discovery of the pieces of the puzzle, and the second is putting the pieces together, or discovery of the nature of the total picture.

Characteristics of Scientific Research

We have argued that science is the preferred way to obtain reliable and valid knowledge about the natural world. In order to produce reliable and justified knowledge, the scientific process relies on several important characteristics. Three of the most important characteristics of scientific research are control, operationalism, and replication.

Control

Control
Elimination of the influence of extraneous variables

Control refers to holding constant or eliminating the influence of extraneous variables so that an unambiguous claim about cause and effect can be made. One of the most important tasks of the psychological researcher is to identify causal relationships, and without control for extraneous variables, this is not possible. It is important that you remember this point: experiments are the preferred research method whenever you need to address the issue of cause and effect. Experiments are conducted in an attempt to answer questions, such as why forgetting occurs, what reduces the symptoms of schizophrenia, or what treatment is most effective for depression. In order to provide unambiguous answers to such questions, researchers must rely on control.

Placebo Effect
Improvement due to partcipants' expections for improvement rather than the actual treatment

For example, when testing the effectiveness of a new drug on depressive symptomology, researchers must control for participants' expectations that the drug will help their symptoms. That's because in some cases, participants will experience improvement in symptoms as a result of thinking that they have received a useful treatment, even when the treatment condition has no value (e.g., a sugar pill). This type of improvement is referred to as the **placebo effect**. Therefore, well-designed experiments testing the effectiveness of new drugs include a control condition where participants receive a treatment in which the "drug" looks like the actual drug, when in fact it does not have the active ingredient of the new drug. If participants receiving the real drug report more improvement than participants receiving the placebo, the researcher can be more confident that the new drug is the actual cause of the improvement. Without the control condition, the researcher would not know whether the cause of the improvement was the drug or the placebo effect.

Operationalism

Operationalism Representing constructs by a specific set of operations

Operational definition Defining a concept by the operations used to represent or measure it

Multiple operationalism Using multiple measures to represent a construct

The principle of **operationalism** was originally set forth by the physicist Percy Bridgman (1882–1961). Bridgman (1927) argued that science must be specific and precise and that each concept must be defined by the steps or operations used to measure them. Length, for example, would be defined as nothing more than the set of operations by which it was measured. If length was measured with a ruler or tape measure graded in terms of inches, length would be defined as a specific number of inches. If length was measured with a ruler or tape measure graded in terms of centimeters, length would be defined as a specific number of centimeters. This type of definition came to be known as an **operational definition**. Operational definitions were initially embraced by research psychologists because they seemed to provide the desired level of specificity and precision. However, using a strict operational definition of psychological concepts didn't last long because of the limitations it imposed.

One of the early criticisms of operational definitions was that their demands were too strict. For example, it would be virtually impossible to formulate a problem concerning the functional relationships among events. Instead of stating a relationship between hunger and selective perception, one would have to talk about the relationship between number of hours of food deprivation and inaccurate description of ambiguous stimuli presented for 500 milliseconds.

Another criticism was that a single operational definition could not completely specify the *meaning* of a term. Any change in the set of operations would specify a new concept, which would lead to a multiplicity of concepts. Such a strict operational definition notion suggests that there is no overlap among the operations—that, for example, there is no relationship among three different operational measures (responses to a questionnaire, galvanic skin response [GSR] readings, and heart rate change) of a concept such as anxiety.

The prominent research methodologist Donald Campbell (1916–1996) criticized operational definitions on the grounds that any set of operations will always be incomplete (Campbell, 1988). For example, aggression has been defined in different research studies as honking of horns, hitting a BoBo doll, delivering electric shocks to another, and the force with which a pad is hit. However, none of these indicators represents a complete definition of aggression. Campbell suggested that a more accurate representation of a construct could be obtained by representing it in several different ways. The use of multiple measures of a construct is called **multiple operationalism**. An advantage of using several different operationalizations of a construct is that confidence in the result is increased if the findings across the different operationalizations are similar. Campbell (1988) also criticized the term *operational definition*. He recommended that the word "definition" be removed from "operational definition" and that researchers simply talk about constructs being "*operationalized*" rather than being literally *defined* by the operations. According to Campbell, an operational definition should be called an **operationalization**.

Operationalization Campbell's term for an operational defintion

The criticisms presented do not mean that operationalism is not important. What is essential for science is that constructs are clearly and effectively represented by a specific set of operations, and this information must be provided when researchers publish their results. Consider the construct of "good car salesperson." How would you operationalize a good car salesperson? What empirical referents would you use to characterize this construct? In Figure 1.1, we suggest that these empirical referents might consist of selling many cars, pointing out a car's good features, helping the customer to find financing, and complimenting the customer on an excellent choice. Once such indicators have been clearly identified, meaning can be communicated with minimal ambiguity and maximum precision.

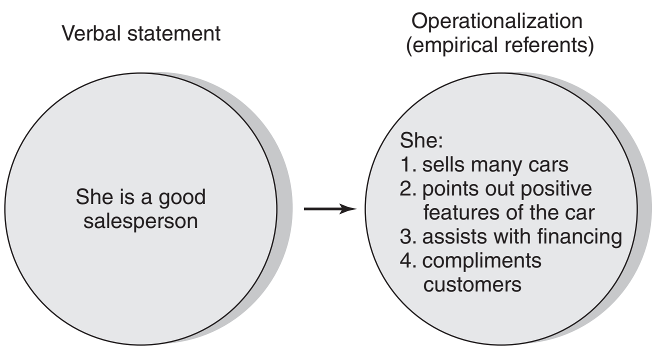
Replication

Replication The reproduction of the results of a study in a new study

Scientific knowledge is greatly advanced by replication. **Replication** refers to the reproduction of the results obtained from one study in additional studies. It is important to remember this key point: Before you can trust the findings of a single research study, you must determine whether the observed results are reliable. You should always be cautious when interpreting findings from a single study in isolation from other research. To make a general claim, you must know whether the same results will be found if the study is repeated. If the observations are not repeatable, the observations were either due to chance or they operate differently in different contexts. If the variables of interest operate differently in different contexts, then contextual factors must be systematically examined in additional research.

Failure to replicate the results of a previous study can be interpreted in several ways because there are many possible reasons why it might occur. The first and most obvious possibility is that the results of the prior study were due entirely to chance, which means that the phenomenon that was previously identified did not really exist. If the phenomenon did not exist, it obviously cannot be reproduced in a replication study. The second reason is that the replication experiment

FIGURE 1.1 Example of an operationalization of a good car salesperson.



might have altered some seemingly nonsignificant element of the experiment, and this element in turn produced an altered response on the part of the research participants. The third reason is that the relationship under investigation might vary across context. In this case, the initial finding does not apply in the new group, time, setting, and so on. For example, social psychological research on gender stereotypes has yielded different findings across the last four decades. These changes in findings (failures to replicate) are very informative.

Although the need for replication is accepted as a characteristic of scientific research, Campbell and Jackson (1979) have pointed out that an inconsistency exists between the acceptance of this characteristic and researchers' commitment to actually conduct replication research. Few researchers conduct exact replication research, primarily because it is difficult to publish such studies. Nonetheless, partial replication of research is readily produced when the key variables are included in multiple research studies. The results of this sort of replication are frequently reported in **meta-analysis** research. Meta-analysis is a quantitative technique that is used to integrate and describe the relationships between variables across multiple research studies. Earlier we noted that you should not place too much trust in the findings of a single research study. You should, however, place significant trust in the results of a meta-analysis because the finding is shown to apply across multiple related research studies. Whenever you review the research literature on a topic of interest, you should be sure to search for meta-analysis research studies!

Meta-analysis
A quantitative technique for describing the relationship between variables across multiple research studies

STUDY QUESTION 1.3 **List and define the characteristics of scientific research. Then, explain why each is a characteristic of the research process.**

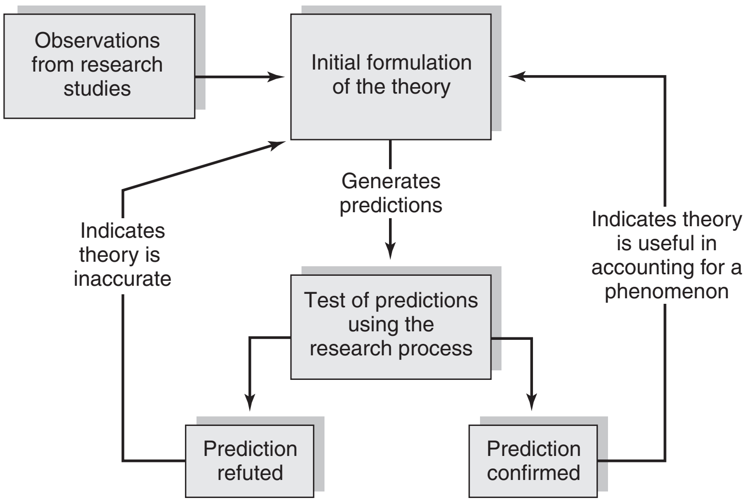
The Role of Theory in Scientific Research

Use of the research process in making objective observations is essential to the accumulation of a highly reliable set of facts. Accumulating such a body of facts, however, is not sufficient to answer many of the riddles of human nature. For example, research has revealed that individuals who are paid less than someone else for doing the same job are more likely to get angry and upset than workers who feel they are fairly compensated. Research has also shown that increases in pay are associated with increases in job satisfaction. Once facts such as these have been accumulated through the use of the research process, they must somehow be integrated and summarized to provide more adequate explanations of psychological phenomena. This is one of the roles that theory plays in the scientific enterprise. Equity theory, for example, summarized and integrated a large portion of the data related to the notion of fairness and justice to provide a more adequate explanation of interpersonal interactions. A **theory** helps to explain how and why a pheonomenon operates as it does.

Theory
An explanation of how and why something operates

Theories are not created just to summarize and integrate existing data, however. A good theory must also suggest new hypotheses that are capable of being

FIGURE 1.2 Illustration of the relationship between theory and research.



Logic of discovery The inductive or discovery part of the scientific process

Logic of justification The deductive or theory-testing part of the scientific process

tested empirically. Consequently, a theory must have the capacity to guide research as well as to summarize the results of previous research. This means that there is a constant interaction between theory and empirical observation, as illustrated in Figure 1.2. From this figure you can see that theory is originally based on empirical observations obtained from research; this is called the **logic or context of discovery;** it's the inductive part of science. Once the theory has been generated, it must direct future research; this is called the **logic or context of justification;** it's the deductive part of science where predictions are derived and empirically tested. The outcome of the future research then feeds back and determines the usefulness of the theory, and this process continues again and again. If the predictions of the theory are confirmed by subsequent research, evidence exists that the theory is useful in accounting for a given phenomenon. If the predictions are refuted by subsequent research, the theory has been demonstrated to be inaccurate and must either be revised so as to account for the experimental data or be thrown out. In short, Figure 1.2 shows that theory *generation* and theory *testing* are valuable parts of the scientific enterprise.

STUDY QUESTIONS 1.4

- **List the basic assumptions of scientific research, and explain why these assumptions are needed.**
- **Explain the role theory plays in scientific research.**

The Role of the Scientist in Psychological Research

One very significant component in research is the scientist—the individual who employs the scientific approach. A scientist is any individual who rigorously employs the scientific research process in the pursuit of knowledge. Is the scientist just any person, or does he or she possess special characteristics? As might be expected, some characteristics are especially important. Because nature's secrets are revealed reluctantly, scientists must actively search and probe nature to uncover orderly relationships, and he or she must strive to be curious, patient, objective, and tolerant of change.

Curiosity

The scientist's goal is the pursuit of knowledge and the uncovering of regularities in nature. Scientists attempt to answer the following questions: What? When? Why? How? Under what conditions? With what restriction? These questions are the starting point of scientific investigation, and they continue to be asked throughout each study and throughout the researcher's career. To adddress these questions, the scientist must be inquisitive, must exhibit curiosity, and must never think that the ultimate solution has been reached. If questions cease, then so does the scientific process.

Scientists must maintain an open mind, never becoming rigid in orientation or in method of research. Such rigidity could cause him or her to become blinded and incapable of capitalizing on, or even seeing, unusual events. Curiosity and careful observation enable Skinner's "fifth unformalized principle of scientific practice . . . serendipity—the art of finding one thing while looking for another" (1956, p. 227). The sort of curiosity suggested here also enables what Louis Pasteur (1822–1895) is believed to have said in 1854: "Chance favors the prepared mind." If scientists were not inquisitive and open to new and different phenomena, they would have never made many of the discoveries of the past.

Patience

The reluctance of nature to reveal secrets is seen in the slow progress made in scientific inquiry. When individuals read or hear of significant advances in some field of scientific inquiry, they might marvel at the scientists' ability and think of the excitement and pleasure that must have surrounded the discovery. Although moments of excitement and pleasure do occur, research often includes many months or years of tedious, painstaking work. Many failures usually precede a success, so the scientist must be patient and be satisfied with rewards that are few and far between. For example, note the many years of effort that have gone into cancer research; many advances have been made, but a cure is still not available.

Objectivity

Objectivity
Goal in science to eliminate or minimize opinion or bias in the conduct of research

One of the goals of the research process is **objectivity**. Ideally, the scientist's personal wishes and attitudes should not affect his or her observations. Realistically, however, perfect objectivity cannot be attained, as scientists are only human. Even if perfect objectivity cannot often be achieved, it is essential to use it as a goal of research. The idea is to minimize the influence of the researcher on the conduct and outcomes of the research process. In order to be objective, however, one must also be critical and reflective because we often cannot "see" our biases. Throughout this book, we will be providing methods and strategies to help you conduct research in ways that strive to maximize objectivity and understanding.

Change

Scientific investigation necessitates change. The scientist is always devising new methods and new techniques for investigating phenomena. This process typically results in change. When a particular approach to a problem fails, a new approach must be devised, which also necessitates change. Change does not require abandoning all past facts and methods; it merely means the scientist must be appropriately critical of the past and constantly alert to new facts and techniques to enable new advances in scientific knowledge. Despite the need for the scientist to accept change as part of the research process, it seems that new ideas are sometimes resisted if they do not somehow fit in with current knowledge. Polanyi (1963), for example, relayed his own experience of the reaction to his theory of the absorption (adhesion) of gases on solids following its publication in 1914. He was chastised by Albert Einstein for showing a "total disregard" for what was then known about the structure of matter. Polanyi, however, was later proved to be correct. The moral is to continually self-examine and to attempt to be open to new ways of viewing the facts and not be blinded or hindered by one's beliefs.

STUDY QUESTION 1.5 | **What are the characteristics a person has to have to be a good scientist, and why are these characteristics necessary?**

Objectives of Psychological Research

Ultimately, the objective of scientific research is to understand the world in which we live. Scientific research demands a detailed examination of a phenomenon. Only when a phenomenon is accurately described and explained—and therefore predictable and, in most cases, capable of being controlled—will a scientist say that it is understood. Consequently, scientific understanding requires four specific objectives: description, explanation, prediction, and control.

Description

Description
The portrayal of a situation or phenomenon

The first objective, **description**, requires that the phenomenon be accurately portrayed. One must identify the characteristics of the phenomenon and then determine the degree to which they exist. For example, Piaget's theory of child development arose from detailed observations and descriptions of his own children. Any new area of study usually begins with the descriptive process, because it identifies the variables that exist. Only after we have some knowledge of which variables exist can we begin to explain why they exist. For example, we would not be able to explain the existence of separation anxiety (an infant's crying and visual searching behavior when the caretaker departs) if we had not first identified this behavior and the age at which it occurs. Scientific knowledge typically begins with description.

Explanation

Explanation
Determination of the cause or causes of a given phenomenon

The second objective is the **explanation** of the phenomenon, and this requires knowledge of why the phenomenon exists or what causes it. Therefore, we must be able to identify the antecedent conditions that result in the occurrence of the phenomenon. Assume that separation anxiety existed only when an infant was handled by few adults other than its parents and that it did not exist when the infant was handled by many adults other than parents. We would conclude that one of the antecedent conditions of separation anxiety was frequency of handling by adults other than the parents. Note that frequency was only *one* of the antecedents. Scientists recognize that most phenomena are multidetermined and that new evidence might necessitate replacing an old explanation with a better one or expanding an explanation to include new information. As the research process proceeds, we acquire more and more knowledge concerning the causes of phenomena. With this increasing knowledge comes the ability to predict and possibly control what happens.

Prediction

Prediction
The ability to anticipate the occurrence of an event

Prediction refers to the ability to anticipate an event prior to its actual occurrence. We can, for example, predict very accurately when an eclipse will occur. Making this kind of accurate prediction requires knowledge of the antecedent conditions that produce such a phenomenon. It requires knowledge of the movement of the moon and the earth and of the fact that the earth, the moon, and the sun must be in a particular relationship for an eclipse to occur. If we knew the combination of variables that resulted in academic success, we could then predict accurately who would succeed academically. To the extent that we cannot accurately predict a phenomenon, we have a gap in our understanding of it.

Control
(1) A comparison group, (2) elimination of the influence of extraneous variables, or (3) manipulation of antecedent conditions to produce a change in mental processes and behavior

Control or Influence

Control refers to the manipulation of the *conditions that determine a phenomenon*. Control, in this sense, requires knowledge of the causes or antecedent conditions of a phenomenon. When the antecedent conditions are known, they can be manipulated to produce the desired phenomenon.

Once psychologists understand the conditions that produce an outcome, the outcome can potentially be controlled by either allowing or not allowing the conditions to exist. Consider the hypothesis that frustration leads to aggression. If we knew that this hypothesis were completely correct, we could control aggression by allowing or not allowing a person to become frustrated. Control, then, refers to the manipulation of conditions that produce a phenomenon, not of the phenomenon itself.

At this point, it seems appropriate to provide some additional insight into the concept of control. So far, control has been discussed in two slightly different ways. In the discussion of the characteristics of scientific research, control was referred to in terms of holding constant or eliminating the influence of extraneous variables in an experiment. In the present discussion, control refers to the antecedent conditions determining a behavior. An experimental psychologist and a historian of psychology, Edwin Boring (1886–1968) noted (1954) that the word *control* has three meanings. First, control refers to a check or verification in terms of a standard of comparison (such as use of a placebo with a control group in a medical experiment). Second, it refers to a restraint—keeping conditions constant or eliminating the influence of extraneous conditions from the experiment. Third, control refers to manipulating conditions to produce an exact change or a specific attitude or behavior. The second and third meanings identified by Boring are those used in this book so far. Because all of these meanings will be used at various times, it would be to your advantage to memorize them.

STUDY QUESTION 1.6

List and define the objectives of research. Then explain why each is an objective of the research process.

Pseudoscience

We have introduced you to science in this chapter. We pointed out that science is the approach to acquiring and establishing the type of knowledge that is relied upon in psychology. Scientific knowledge has a special status in our society because this type of knowledge claim is not made by scientists until a high degree of reliability and validity has been obtained. Now we will take another look at science by examining what it is not. Science is contrasted with pseudoscience.

Pseudoscience
Set of beliefs or practices that are not scientific but claim to be scientific

Pseudoscience is an approach that claims to be scientific but is based on methods and practices that violate many tenets of science. Pseudoscientific claims often are made in an attempt to gain legitimacy. For example, commercials often claim that their products' effectiveness has been "scientifically proven," when the claim is based on no credible evidence. Other examples of pseudoscience are found in astrology, ESP, fortune-telling, flat-earth claims, and superstitions. In Table 1.2, we list some strategies commonly relied upon in pseudoscience. You should avoid these faulty strategies when conducting research because they show what science is not.

STUDY QUESTIONS 1.7

- **What is pseudoscience?**
- **What are the faulty strategies used in pseudoscience?**

TABLE 1.2
Strategies Used in Pseudoscience

- Creating new (ad hoc) hypotheses in order to explain away negative findings.
- Exclusive use of confirmation and reinterpretation of negative findings as supporting the claim.
- Absence of self-correction through continual and rigorous testing of the claim.
- Reversed burden of proof (i.e., stating that the onus of proof is on the critics).
- Overreliance on testimonials and anecdotal evidence supporting a claim.
- Use of obscurantist language to make a claim sound as if it has survived scientific scrutiny.
- Absence of any connection to other disciplines that study issues related to the claim.

Summary

This chapter provides an introduction to psychological research and science. The key ways that people acquire knowledge are intuition (i.e., based on preconscious processes), authority (i.e., based on what authorities say), rationalism (i.e., based on reasoning), and empiricism (i.e., based on experience). Science is a very special mixture of the approaches just mentioned, and it is the most trustworthy way to acquire reliable and valid knowledge about the natural world.

During its history, science has emphasized different inquiry approaches. From the seventeenth century to about the middle of the nineteenth century, induction was the primary scientific methodology. From about 1850 to about 1960, hypothesis testing was the primary scientific methodology. During this period, the logical positivists emphasized verification of hypotheses. Popper, who was not a logical positivist, emphasized attempting to falsify hypotheses and theories. Both the logical positivists' principle of verificationism and Popper's principle of falsification have some problems when taken singularly. In the current period, a mixture of verificationism and falsificationism is used. Since 1960, we have entered a methodological era of *naturalism* that says we should justify science empirically rather than through philosophical argument. Science during the periods of naturalism is marked by a mixture of ideas from previous periods; it is a pragmatic approach that is focused on the empirical adequacy of our hypotheses and theories and focuses on finding what works in practice. Naturalism was also influenced by the ideas of Thomas Kuhn (who talked about paradigms) and Imre Lakatos (who focused on research programs). Paul Feyerabend took a "radical position" and argued that science used so many different approaches that it could be viewed as anarchistic.

Although it is true that there is no single, simple definition of science that distinguishes it from nonscience, we offered a working definition: Science is the preferred way of acquiring reliable and valid knowledge about the natural world, including methods for obtaining scientific knowledge, standards for judging whether the knowledge is warranted or justified, and, finally, a set of facts and theories constituting the current status of the science. The primary assumptions of science are as follows: (1) there is uniformity or regularity in nature, (2) nature is real including our experiences of it, and (3) discoverability (i.e., it is possible to discover regularities in nature).

Three major characteristics of science are control, operationalism, and replication. *Control* is the most important characteristic because it enables the scientist to identify causation; without control, it would be impossible to identify the cause of a given effect. *Operationalism* means researchers must clearly represent their constructs according to the operations used during measurement. Perhaps the best way to operationalize a concept is through multiple operationalism (i.e., the use of multiple measures to represent a construct). *Replication* occurs when the results of a study are shown to occur again in future studies. Meta-analysis is an excellent way to summarize the results across multiple studies.

Theory is an important part of science. When relying on the logic of discovery, theories are generated, discovered, and developed. When relying on the logic of justification, theories are systematically tested with new empirical data to determine how well they operate. Science continually moves back and forth between theory discovery and theory testing (or induction and deduction), as shown in Figure 1.2.

Scientists should be curious, must have patience, must try to be objective, and must be open to change. The four major objectives of psychological research are description, explanation, prediction, and control or influence. Pseudoscience is a set of beliefs or practices that claim scientific status but are not scientific. You should avoid the strategies listed in Table 1.2, which characterize bad science or pseudoscience.

Key Terms and Concepts

Authority
Control
Deduction
Description
Determinism
Discoverability
Duhem–Quine principle
Empirical adequacy
Empiricism
Explanation
Falsificationism
Hypothesis testing
Induction
Intuition
Logic of discovery
Logic of justification
Logical positivism
Meta-analysis
Multiple operationalism
Naturalism
Normal science
Objectivity
Operational definition
Operationalism
Operationalization
Paradigm
Placebo effect
Prediction
Probabilistic causes
Pseudoscience
Rationalism
Reality in nature
Replication
Research program
Revolutionary science
Science
Theory

Related Internet Sites

http://www.pbs.org/wgbh/aso/databank/humbeh.html
This Internet site gives a short summary of the training and scientific contributions made by 11 scientists who figure very prominently in the history of psychology. This site also gives a brief discussion of a number of discoveries made by scientists from the early 1900s to 1993 that have significantly impacted the field of psychology.

http://quasar.as.utexas.edu/BillInfo/Quack.html
This Internet site has an entertaining discussion on a number of flaws that characterize “bogus” theories.

http://psychology.wadsworth.com/workshops/workshops.html
This Internet site gives a link to a workshop in statistics and research methods. For Chapter 1, go to this Internet site and click on the Web page link corresponding to the workshop titled “Research Methods Workshops.” Then click on the “What Is Science?” link.

http://www.chem1.com/acad/sci/pseudosci.html
This Internet site discusses pseudoscience and how to recognize it.

Practice Test

Five multiple choice questions are included at the end of each chapter to enable you to test your knowledge of the chapter material. If you would like a more extensive assessment of your mastery, you can go to the Allyn and Bacon Web site accompanying this textbook, where you will find additional review questions. Prior to taking these sample tests, you should study the chapter. When you think you know the material, take the practice test to get some feedback regarding the extent to which you have mastered the material.

The answers to these questions can be found in Appendix.

1. Empiricism is a vital element in scientific studies. What does empiricism refer to?

a. acquiring knowledge through experience
b. A person’s personal opinions about phenomena in the world
c. Tenacious determination to hold onto one’s current beliefs
d. Accepting information because it comes form an authority

2. Scientific activities have included

a. Induction
b. Hypothesis testing
c. Paradigms
d. Research programs
e. All of the above

3. Professor Albert was conducting an experiment investigating the influence of “status” on a person’s persuasive influence. In this study, he manipulated the variable of status by presenting different dress styles. In particular, a high-status person was dressed in an expensive business suit and carried a briefcase. The low-status person was dressed in faded jeans and torn shirt. The difference in dress styles of the high- and low-status person was used to

a. Control for the influence of extraneous variables
b. Operationalize the construct of status

c. Enable him to replicate the results of his study
d. Control for the type of dress the participants wore

4. If you conducted a study in which you wanted to determine why help is not given to people who obviously need it, with which of the following objectives would you have conducted the study?

a. Description
b. Explanation
c. Prediction
d. Control

5. Scientists usually make several assumptions in order to have confidence in the scientific research process. Which of the following is *not* one of these assumptions?

a. There is an underlying reality in nature including what we see, hear, feel, touch, and taste.
b. It is possible to discover the regularities in nature.
c. There is uniformity or regularity in nature.
d. Psychology studies only psychologically constructed reality.

Challenge Exercises

In addition to the review questions, each chapter ends with challenge exercises. These exercises will encourage you to think about the concepts discussed in the chapter to give you an opportunity to apply what you have learned.

1. Psychology makes use of many concepts when explaining mental processes and behavior and when conducting research. Consider each of the following concepts, and identify a set of operations that will be representative of each concept.

a. Depression
b. Aggression
c. Child abuse
d. Attitude
e. Leadership

2. The medical community has repeatedly expressed concern about the fact that the average weight among Americans is increasing. The concern focuses on the health risks of people who are overweight. Think about each of the four major objectives of science, and apply each of these objectives to this concern of the medical community.

3. What would happen to the science of psychology if none of the assumptions underlying science existed? What would happen in our daily lives if these assumptions did not exist?

4. Identify an area that would be considered to be pseudoscientific, such as astrology, palm reading, and ESP. Find evidence for claims made by these fields, and explain why this evidence is pseudoscientific.

5. Are the following fields scientific or pseudoscientific? Justify your answer.

a. Chiropractic medicine
b. Faith healing
c. Homeopathy
d. Acupuncture
e. Parapsychology