SIXTH EDITION

Beginning Behavioral Research

A Conceptual Primer

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CHAPTER 1

Behavioral Research and the Scientific Method

Preview Questions

- Why study research methods and data analysis?
- What rival alternatives are there to the scientific method?
- What is empirical reasoning?
- How is empirical reasoning used in psychological science?
- How do extraempirical factors play a role?
- What does behavioral science encompass?
- What do methodological pluralism and theoretical ecumenism connote?
- How does research go from descriptive to relational to experimental?
- What are the characteristics of good researchers?

Why Study Research Methods and Data Analysis?

Reading, 'riting, and 'rithmetic—the three Rs—have been traditionally viewed as the fundamentals of education that we have been taught since grade school. A fourth R, "researching" (or exploring a question systematically), is now regarded as another crucial skill for any educated person (Hult, 1996). In high school, you were introduced to the steps involved in "researching" a term paper. In college science courses, the term *researching* implies the use of an approach traditionally called the **scientific method**. Embracing all branches of science, the applications of this approach vary from one research discipline to another. Researchers in disciplines as varied as psychology, biomedicine, business, education, communication, economics, sociology, anthropology, physics, biology, and chemistry all use some variation of this approach. However, you may be wondering why you need to know about the scientific method or to study techniques of research and data analysis if becoming a researcher in one of the above-mentioned areas is not your ultimate goal. There are at least five good reasons.

One is that our modern way of life is largely the creation of science and technology, and we enhance our understanding of the full range of this influence by learning about the logic and evidence used by researchers to open up the world to scrutiny and explanation. By analogy, viewing paintings, drawings, and sculpture in a museum becomes more meaningful when we know something about the processes and creative ideas that were involved in producing the works of art. Similarly, when we understand how the conclusions were reached, we can attach more meaning to reading that a scientific poll of likely voters found Candidate X ahead of Candidate Y by 4 percentage points with a 5% margin of error, or that a longitudinal study found that higher quality child care is related to advanced cognitive and language skills, or that an epidemiological study found a significant relationship between health problems and exposure to some environmental substance, or that a randomized trial showed a new drug to be effective in treating depression.

Besides the richer appreciation of the information that science brings to our lives, a second reason for studying research methods is that *not* clearly understanding how researchers cast and address questions sometimes costs us dearly. Doctors, teachers, lawyers, the clergy, and politicians have an influence on our daily lives, and most of us are familiar with how people in these fields go about their work. But few of us seem to have even a vague idea of how researchers create and test hypotheses and theories that enlarge our understanding of the world. As a consequence, people often give credence to misleading recommendations based on bogus data or succumb to claims for cure-all remedies or panaceas for warding off diseases when there is not a shred of reliable evidence of their effectiveness apart from the power of the placebo effect. Studying the conceptual bases of various research methods, and having the opportunity to conduct an empirical study and to analyze and interpret the data under the watchful eye of an experienced guide, will begin to sensitize you to the difference between well-grounded scientific conclusions and dubious claims masquerading as generalizable facts.

A third reason is to acquire information and skills you can use later. For example, once you have mastered the discussions of data analysis in the later chapters of this book, you should be able to raise and address statistical questions of your own choosing. A case in point is news reports about dramatic findings in randomized trials of new drugs. Once you have mastered the analysis of 2 × 2 frequency tables in Chapter 15, you will be able to use a calculator to estimate the magnitude of the outcome results in the population even when all you have are limited raw ingredients. In Chapter 12, you will learn that the "statistical significance" of a result does not actually tell us the degree to which the phenomenon is present in the population. If you are preparing for a career in health care, it is important that you understand the difference between statistical and practical significance. However, such understanding is not limited just to careers in health care. In business or government and policymaking, or in any other decision-making field, you will be served well by a conceptual understanding of basic methods of data analysis and what they can and cannot tell us, of how it is possible statistically to generalize from the known to the unknown, and of the risk of seeing something that is not there, balanced against the risk of *not* seeing something that *is* there.

A fourth reason for studying (and doing) research is to learn about the limits of particular studies and methods. All studies are limited in some way, but an important question is the degree to which the meaning and generalizability of the results are circumscribed by specific constraints. For example, correlations in epidemiological studies may be partly (or sometimes entirely) due to variables other than those measured, and results in experimental trials of new drugs administered to young, healthy, mobile volunteer subjects may not apply to aged, infirm, hospitalized patients with advanced diseases (Brody, 2002). Both of those limits are explored later in this book. In Chapter 3, we discuss the limits imposed by review boards that are charged with overseeing the ethical responsibilities of scientific researchers. In research with human participants, another limitation occurs when those whose behavior is being studied know they are being observed for some scientific purpose; they may behave quite differently from those who don't know. In Chapter 7, we describe techniques used by researchers to overcome this problem, although these techniques are also limited in some ways. However, despite limitations, behavioral and social researchers have formulated empirically grounded answers to questions about how and why humans feel, think, and behave as they do (see also Box 1.1).

A final reason for studying and doing research is that some students will find this activity so much fun and so absorbing that they may want to make a career of it!

What Rival Alternatives Are There to the Scientific Method?

The scientific method is not the only approach commonly used to make sense of things and give us information. Philosophers, novelists, and theologians seek to give us a coherent picture of our world, but they do not use the scientific method

BOX 1.1 The Provisional Nature of Scientific Knowledge

Because even the most carefully designed study is limited in some way, scientific knowledge is in a constant state of development. For many years, philosophers and historians of science have speculated on the pattern of this development. Thomas S. Kuhn (1962, 1977), a physicist turned scientific historian, believed that major advances in science appear as "paradigm shifts" resulting from revolutionary insights. Karl Popper (1963, 1972), an Austrian-born British philosopher of science, compared progress in science with Charles Darwin's theory of "survival of the fittest." Popper's idea was that the fittest scientific formulations withstand falsification in what resembles an evolutionary process of competition and survival. No matter whether the development of science is viewed as revolutionary or evolutionary, on one point all seem to agree: Scientific knowledge is relative and provisional. As one researcher put it, "Scientists know that questions are not settled; rather, they are given provisional answers for which it is contingent upon the imagination of followers to find more illuminating solutions" (Baltimore, 1997, p. 8).

to organize ideas and explain things. What is distinctive about the different approaches used by scientists and nonscientists to formulate a sense of understanding and belief? One scholar who was fascinated by this question was the American philosopher Charles Sanders Peirce (1839–1914). Peirce conceived of the scientific method as being one among four distinctive approaches to explaining things and providing a foundation for strongly held beliefs; he called this process "the fixation of beliefs." Peirce (pronounced "purse") called the other three approaches the *method of tenacity*, the *method of authority*, and the *a priori method*. Each, he argued, is characterized by a particular formulaic way of thinking and behaving (Peirce, 1966).

Peirce thought the **method of tenacity** was the most primitive approach of all, because it is bound by tradition and involves clinging stubbornly (tenaciously) and mindlessly to claims or beliefs because they have been around for a while. People who exhibit this kind of knee-jerk behavior are like the ostrich that buries its head in the sand, he said, because they go through life excluding anything that might challenge or alter their beliefs. Sometimes it seems that a whole society has fallen victim to some outlandish notion merely because it has been around for a long time, and it is not easy to shake fixed beliefs or to open up closed minds (Mitchell, 1985). For example, beginning with the Ptolemaic treatise in the 2nd century A.D., people were convinced that the earth was fixed, immobile, and at the center of the universe. It was one of the ancient astronomer Ptolemy's few misconceptions, but it was a whopper that endured for over a thousand years. It was not until Copernicus's insight that the sun, not the earth, is the center of the universe that the geocentric (i.e., earth-centered) design was challenged, although the Copernican system also left much room for improvement (it neglected to show that the sun is a center of force). Indeed, it was not until the advent of modern astronomy, or what one historian called the "witness of the naked eye" (Boorstein, 1985, p. 305), that the geocentric design was finally swept away by the scientific method.

In our own time, the method of tenacity still has a pernicious hold on many people's convictions and superstitions (see, e.g., Box 1.2). Peirce thought that superstitions and other dogmatic beliefs are like the cadence that concludes a musical phrase in a symphony and provides closure. Sometimes this closure seems to be based on what social psychologists call a "false consensus" or "pluralistic ignorance"; it means that people have a tendency to misperceive, and frequently to overestimate, the extent to which others believe the same thing (Kelley & Thibaut, 1969; Ross, Greene, & House, 1977). Telling themselves that only their beliefs are correct, they dismiss counterarguments as deviant and seek out information that is consistent with their own biases about how the world should be understood (Marks & Miller, 1987; Ross et al., 1977; Sherman, Presson, & Chassin, 1984). Classic research by psychologist Milton Rokeach (1960) resulted in measures of the degree of dogmatism, or closed-mindedness, showing that people who score high on dogmatism are not only highly defensive about their beliefs but less likely to act on the plausible merits of information independent of their subjective impression of the source (Powell, 1962).

BOX 1.2 Flying Saucers, Big Foot, and Other Odd Beliefs

Myth, folklore, and superstition illustrate the method of tenacity's powerful hold on beliefs that can endure for centuries. The noted Swiss psychiatrist and psychologist Carl G. Jung (1910, 1959)—one of Sigmund Freud's students—theorized about the persistence of stories of "flying saucers," unidentified flying objects (UFOs) piloted by extraterrestrials. This stubborn myth, he argued, is a projection of people's fears and uncertainties about the world situation and their wish for a redeeming supernatural force. Interestingly, the UFO story usually takes one of two forms: It is said either that benevolent superior beings from another planet have come to save humanity (as represented in the 1951 movie *The Day the Earth Stood Still*), or that menacing creatures threaten humanity and this threat will unify people of diverse ideologies to make a stand against a common foe (represented in the 1996 movie *Independence Day*). There are also people who still insist that the earth is flat, that sunrise and sunset are optical illusions, and that the 1969 moon landing was an elaborate hoax staged in a hangar in Arizona (D. Martin, 2001). In a fascinating case, it was revealed a few years ago that a prankster named Ray L. Wallace had created the modern myth of Bigfoot (or Sasquatch), the name for the giant, hairy, upright biped rumored to be living in the woods of the Pacific Northwest. After Wallace's death in 2002, his family displayed the carved wooden feet that he had used to stamp a track of oversized footprints. Despite all evidence to the contrary, Bigfoot defenders still insist that the creature exists (Egan, 2003).

The **method of authority** was Peirce's term for the presumption that something is true because someone in a position of authority says it is. Peirce saw that blind obedience to authority is similar in some ways to the method of tenacity (both imply conformity), but he thought the method of authority superior in some ways, although flawed. To illustrate the negative side, he described the violence that resulted when ordinary people obeyed the word of authority to cruelly punish those accused of witchcraft. Unimaginable atrocities committed in the Holocaust during World War II and "ethnic-cleansing" carnage occurring even today are instances of the heights of cruelty that can be reached in the name of a malevolent authority. Other present-day examples on the negative side include unscrupulous people who pose as authorities, preying on human weakness by using fakery. Think of medical quacks, food faddists, faith healers, TV psychics, cult leaders, and eccentric sexual theorists (M. Gardner, 1957; Shermer, 1997). The authority of these fakers and hucksters is in the eyes of their victims, however, so that it behooves the buyer to beware.

Peirce thought the method of authority was at least a small improvement on the method of tenacity because civilized society would cease to exist without people's willingness to obey just laws and to carry out reasonable orders. Researchers are subject to the benevolent authority of an ever-evolving social contract between science and society concerning the rights of research participants and the privileges granted to researchers (Rosnow, 1997). Other examples on the positive side are the astute physician who prescribes a drug or regimen to cure an illness, the skilled electrician who advises the replacement of wiring that is about to burn out, and the expert mechanic who warns that the brakes on a car are worn and need replacing. We depend on their honesty and the authority of their expertise. On the other hand, not everyone perceives the same source as credible, and thus some people are quite willing to accept claims that others reject as preposterous. One writer discussed consumers who reject the medical establishment but often unquestionably accept the authority of someone without the slightest medical expertise or qualification, who, in their minds, makes a "credible" case for the medicinal value of a health supplement that was never critically tested (R. Walker, 2006).

Even if we know very little about medicine, wiring, or brakes, we can use a third strategy of Peirce's to ask questions to help us better understand the authoritative recommendations. The defining characteristic of this third strategy—the **a priori method**—is that people rely primarily on their individual powers of reason and logic to make sense of the world and to explain it to others. This strategy, Peirce (1966) argued, is "far more intellectual and respectable" than the previous two (p. 106); it has proved itself quite robust in the hands of mathematicians and philosophers. In fact, we use the a priori method all the time. When we balance our checkbooks, ruminate on what career path to take, or figure out the amount of a tip in a restaurant, we bring reason and logic into play. Thinking rationally and logically is an effective defense against hoaxes and hucksters who depend on human gullibility. We can approach dubious claims with a questioning mind that, as one psychologist put it, "resists being overly impressed" (Gilovich, 1991, p. 187). Similarly, when people pass on malicious gossip, we can ask where they heard it and how they know it is true. The person who tells it to us may be dependable, but we may question the objectivity of the person who originated it.

It is hard to find fault with the a priori method, but Peirce cautioned that it is constrained by the limits of pure reason. Suppose you conclude that A causes B, and I disagree. Do we just have to let it go at that? What we need, Peirce said, is a way of drawing on nature to help us resolve our dispute. This is the role of the scientific method, to provide a framework for drawing on independent realities to evaluate claims rather than to depend only on tradition, authority, or armchair reasoning. As a noted researcher once said, we use the scientific method in psychology to help us sort out what we know about human nature from what we only think we know (Milgram, 1977). The scientific method depends heavily on the use of empirical research (**empirical** means "based on observation"). The term *scientific method* is actually a misnomer, however, because it is not synonymous with just a single, fixed empirical method; instead, it embraces a great many procedures and empirical techniques. In particular, it can be distinguished by what we define next as *empirical reasoning*.

What Is Empirical Reasoning?

By **empirical reasoning**, we mean a combination of careful logic, organized observation, and measurement that is open to scrutiny by others. One scientist used the following analogy to describe how this idealized process works: Suppose someone is trying to unlock a door with a set of previously untried keys. The person reasons, "If this key fits the lock, then the lock will spring when I turn the key" (Conant, 1957, p. xii). Similarly, the scientist has a choice of "keys" in the form of hunches and empirical techniques, logically decides on one, and then says, "Let's try it." The same "key" is available to other researchers with the knowledge, resources, and skill to use it to open up the world for scrutiny and measurement. In theory, it is this dependence on accessible logic, observation, and measurement (i.e., on empirical reasoning) that unifies research scientists, no matter their specialized field or the focus of their research.

The use of empirical reasoning goes back centuries (see Box 1.3). If you took a physics course in high school, you will recall the story of how Galileo, in the 16th century, reasoned that dropping two objects of different weights from the Leaning Tower of Pisa would prove Aristotle was wrong when he insisted that heavier objects fall faster than lighter ones. (When American astronauts landed on the moon, they successfully conducted an experiment showing that Galileo's principle worked on the moon.) Another early example of empirical reasoning is Newton's use of a prism to show that white light is a combination of different colors

BOX 1.3 Empirical Reasoning in Ancient Times

An early illustration of empirical reasoning was described in a work by Athenaeus of Naucratis (in Egypt), a 2nd-century Greek philosopher (Yonge, 1854). Athenaeus had been convinced by the governor of Egypt that citron ingested before any kind of food was an antidote for "the evil effects from poison" (p. 141). It seems the governor had condemned some robbers to being given to wild beasts and bitten by asps. On their way to the theater where the execution was to be carried out, they passed a woman who was selling fruit and, taking pity on them, gave them citron to eat. When they were later bitten by the beasts and asps, they suffered no injury. When told about the episode in the marketplace, the governor reasoned that it must have been the citron that had saved their lives. He ordered the sentence to be carried again the next day, but that citron be given to some of the prisoners before they were bitten. Those who ate the citron survived when they were bitten, but the others perished immediately. According to Athenaeus, this grotesque experiment was replicated several times and included various ways of preparing the citron.

(not a pure form of light, as Aristotle had claimed), and that each color remains pure when refracted through a second prism. If you have visited a science museum, you may have seen a perpetually swinging iron ball suspended from a wire, with a stylus on the ball tracing a slightly different clockwise pattern in the sand beneath it with each revolution. This construction goes back to the mid-19th century and the idea of a French scientist, Jean-Bernard-Léon Foucault, who wanted to show convincingly that the earth revolves on its axis. (Incidentally, in the Southern Hemisphere the rotation of Foucault's pendulum is counterclockwise, and on the equator, it does not move at all.)

How Is Empirical Reasoning Used in Psychological Science?

Empirical reasoning entered into the scientific study of behavior at the end of the 19th century when the creative advances inspired by the applications of the scientific method in physics and biology led to the development of psychology as a distinct science. In Leipzig, Germany, Wilhelm Wundt (1832–1920), trained in medicine and experimental physiology, built the first formal experimental laboratory for studying psychological behavior. Around the same time, William James (1843–1910), who had a background in philosophy and physiology, announced a graduate course in psychology at Harvard University in which the students participated in experiments that he arranged. Empirical reasoning was not practiced only in the laboratory or only experimentally. In Britain, Sir Francis Galton (1822–1911) demonstrated its application to questions that had been previously thought to lie completely outside science (Forrest, 1974).

In one of his many fascinating studies, Galton explored empirical grounds for the belief that prayers are answered. In England, the health and longevity of the royal family were prayed for weekly or monthly nationwide. Galton asked: Do members of royal families live longer than individuals of humbler birth? In 1872, in an article entitled "Statistical Inquiries Into the Efficacy of Prayer," published by the *Fortnightly Review,* Galton reported that, of 97 members of royal families, the mean age attained by males had been 64.04 years. Compared to 945 members of the clergy, who had lived to a mean age of 69.49; 294 lawyers who had lived to 68.14; 244 doctors who had lived to 67.31; 366 officers in the Royal Navy who had lived to 68.40; 569 officers of the Army who had lived to 67.07; and 1,632 "gentry" who had lived to 70.22, members of royal families had fared worse than expected based on the many prayers on their behalf (Medawar, 1969, p. 4). Galton could not, of course, control for any differences in the sincerity of all those prayers, nor did he reject the idea that religious faith can have a powerful effect in other ways. Prayer, he observed, may strengthen people's resolution to face hardships and bring serenity in distress (Medawar, 1969, p. 5), although for some it may also be a source of stress or confusion (cf. Exline, 2002; Myers, 2000; Pargament, 2002).

Since the time of Wundt, James, and Galton, there has been phenomenal growth in the application of empirical reasoning to questions about human nature, cognition, perception, and behavior. Open any introductory psychology text, and you will find hundreds of contemporary and classic examples, and there are also hundreds of research journals in the behavioral sciences that regularly publish reams of empirical studies. Throughout this text we mention examples of classic and contemporary applications. To begin, let us look at two fascinating experiments: one by Stephen J. Ceci and his coworkers at Cornell University in developmental psychology, the second by Solomon Asch in social psychology. Each study illustrates the application of empirical reasoning in a context of tightly controlled observation and measurement. Each was also seminal in expanding our theoretical understanding of human suggestibility as well as in setting a course for follow-up studies by other researchers. Each also used a form of deception, a topic explored in depth in Chapter 3.

Ceci and his colleagues focused on the accuracy of children's eyewitness testimony. They designed an experiment in which a character named "Sam Stone" was described to 3- to 6-year-olds as someone who was very clumsy and broke things (Ceci & Bruck, 1993, 1995; White, Leichtman, & Ceci, 1997). A person identified as Sam Stone visited the children's nursery school, where he chatted briefly with them during a storytelling session, but he did not behave clumsily or break anything. The next day, the children were shown a ripped book and a soiled teddy bear and were asked if they knew how the objects had been damaged. Over the course of the next 10 weeks, the children were reinterviewed. Each time, the interviewer planted stereotypical information about Sam Stone, such as "I wonder whether Sam Stone was wearing long pants or short pants when he ripped the book?" or "I wonder if Sam Stone got the teddy bear dirty on purpose or by accident?" The result of this manipulation was that the planted stereotype of Sam Stone carried over into the children's eyewitness reports. When asked, 72% of the 3- to 4-year-olds said that Sam Stone had ruined either the book or the teddy bear, and 45% of these children claimed that they had actually seen him do it (and they embellished their accounts with other details). The researchers used a comparison (*control*) group against which to assess the effect of their experimental manipulation. Children in the control group underwent the suggestive interviews, but they received no planted stereotypical information about Sam Stone. Ceci's finding was that the children in the control group made fewer false claims than the children in whom the stereotype had been planted.

Asch (1952) was interested in the degree to which people with normal intelligence will resist mindlessly conforming to a consensus view when faced with an objective reality that shows the consensus view to be false. In this famous experiment, a subject arrived at the psychology lab along with several other participants, who were actually accomplices of the experimenter. Seated together at the same table, all of the participants were told by the experimenter that they would be asked to make judgments about the length of several lines. Each person was to judge which of three lines was closest in length to a standard line. The accomplices always stated their opinions first, after which the subject expressed an opinion. The accomplices, instructed by the experimenter to act in collusion, sometimes gave obviously incorrect opinions, but they were unanimous. A third of the subjects, Asch found, gave the same opinion as the accomplices. When interviewed later, these subjects gave different reasons for yielding to the pressure exerted by the incorrect majority: (a) unawareness of being incorrect; (b) uneasiness about their own perceptions; and (c) wanting to appear the same as the majority. The predominant response of all the subjects, however, was to respond with what was objectively true rather than to go along with the false majority. The theoretical and moral implications of this classic study continue to be amplified in social psychology (Hodges & Geyer, 2006).

How Do Extraempirical Factors Play a Role?

In Asch's experiment, the idea was to see whether people would depend on their own independent observations and resist a majority consensus that was clearly false. The reliance of the scientific method on empirical data and logical reasoning also emphasizes the *primary* role of independent observation to ascertain what is true, but extraempirical factors play a role in science just as they do in everyday life. One reason is that universal laws require a leap of faith because of the limitations of human observation. As an illustration, one of the most powerful laws of science is Newton's first law of motion, which asserts that a body not acted on by any force will continue in a state of rest or, if the body is moving, remain in uniform motion in a straight line forever. Belief in this law is based partly on a leap of faith, however, because obviously no scientist can claim to have *observed* "a body not acted on by any force" (e.g., friction or gravity), much less *observed* a body moving "in a straight line forever." Empirical reasoning thus concedes that there are aspects of reality that are beyond the bounds of our ability to observe them, but this does not abrogate the ideal of generating far-reaching theories and laws based on what we *can* observe.

Philosophers of science have argued that one of several extraempirical factors in science is a sense of beauty or elegance, described as the **aesthetic aspect of science** (Chandrasekhar, 1987; Garfield, 1989a, 1989b; Gombrich, 1963; Hineline, 2005; Nisbet, 1976; Wechler, 1978). For example, it is not uncommon to hear a scientist say that some study or finding or theory is "beautiful." A famous case was Albert Einstein's theory of general relativity, which an eminent mathematician (Paul Dirac) said was so beautiful that it *had* to be true (Kragh, 2002). As another example, several years ago, a science magazine invited readers to nominate the *most beautiful experiments in physics*. The top 10 included Galileo's Tower of Pisa hypothetical experiment, Newton's prism experiment, and Foucault's pendulum. The respondents also offered a range of definitions of beauty in science, including the "economy" of the procedure and what they called "deep play" (meaning that the experiment was incredibly absorbing and engaging). The top 10 experiments were thought to epitomize beauty in the classical sense, in that the logic and simplicity of the apparatus or analysis in each case seemed "as inevitable and pure as the lines of a Greek monument" (G. Johnson, 2002, p. F3).

Another extraempirical factor that has been discussed is frequently called *visualization*, but we prefer a more general term **perceptibility**, by which we mean that scientists often use images in the form of analogies and metaphors to explain the operation of complex phenomena. Analogies and metaphors, in which we try to imagine one thing in terms of another, offer a way of trying to make complex ideas more digestible (an analogy!) without, as one writer put it, "slipping into trivia and meaninglessness" (Perloff, 2006, p. 315). Much has been written about the use of analogies and metaphors not only in science but also in everyday life (Barker, 1996; Billow, 1977; Gentner, Holyoak, & Kokinov, 2001; Gentner & Markman, 1997; Gigerenzer, 1991; Holyoak & Thagard, 1997; Kolodner, 1997; Lakoff & Johnson, 1980; Leary, 1990; A. I. Miller, 1986, 1996; Oppenheimer, 1956; Randhawa & Coffman, 1978; Weiner, 1991). "Her life was an uphill climb" and "He is between a rock and a hard place" are everyday examples of this usage. In physics, a famous case occurred when the quantum theorists first tried to convince colleagues that, given a great many atoms, all capable of certain definite changes, the proportion of atoms undergoing each change could be estimated, but not the specific changes that any given atoms would undergo. Einstein's pungent metaphor to express his visceral dislike of that theory was that God "does not play dice with the world" (Clark, 1971; Jammer, 1966). What makes this imagery so affecting is that we perceive in our "mind's eye" what Einstein meant (see also Bauer & Johnson-Laird, 1993; Johnson-Laird, 1983; Johnson-Laird & Byrne, 1991; Robin, 1993).

Another extraempirical factor is the **rhetoric of justification** that is used to build a case in support of some conclusion. As Yale psychologist William J. McGuire (2006) put it, "Because researchers are verbal people, they usually express their knowledge in the verbal modality, oral or written" (p. 356). Indeed, every specialized field has its own rhetoric of justification (A. G. Gross, 1990; Pera & Shea, 1991): Lawyers sound like lawyers, philosophers like philosophers, doctors like doctors, scientists like scientists, and so on. To understand what people in different fields are saying, we must understand the terms and concepts they are using. For example, McGuire (2006) went on to say, "When the verbalization is formally scientific (rather than colloquial), it typically takes the form of a hypothesis (proposition, statement) expressing the relation among the two or more variables, usually either a main-effect, interactional, or mediating relation" (p. 356). What are a *hypothesis,* a *main-effect* relation, an *interactional* relation, and a *mediating* relation, and what do behavioral and social researchers mean when they say they have done *debriefing of subjects* or have done a *participant observation study* or used *back translation,* or that *intercoder reliability* was a particular value? We define these and many other specialized terms throughout this book.

Another aspect of this rhetoric is that professional researchers are expected to publish their empirical results in *peer-reviewed journals* (i.e., before the articles are actually accepted for publication, they undergo reviews by experts in the field). In Appendix A, you will find a sample report that is structured in the way that many research reports are in psychology and other areas that have adopted the "APA style" (the style recommended in the latest edition of the *Publication Manual of the American Psychological Association*). This structure, which evolved over many years, currently consists of an abstract (or summary), an introduction, a method section, a results section, a discussion section, and a list of the references cited in the report. The purpose of having a standardized organization is that it enables busy researchers to read research articles more easily (because they conform to a similar structure) and it encourages authors to organize their thoughts in a systematic way as they report their research to others.

What Does Behavioral Science Encompass?

The examples we have mentioned cover a range of disciplines, including psychology, physics, and astronomy. However, this book is not just a trip into the realm of science in general; it is a journey into the domain of behavioral science in particular. **Behavior** is what you do and how you act; **behavioral science** is an umbrella term that covers cognitive and emotional functioning as well as social behavior (social science) and behavioral economics. As the term is defined in this broad way, the range of interests of behavioral scientists includes the study of early primitive humans, and of humans as political animals, financial animals, social animals, talking animals, and logicians. These aspects of human nature are the concern of psychologists (e.g., clinical, cognitive, counseling, developmental, educational, experimental, organizational, personality, and social), mass communication researchers, sociologists, cultural anthropologists, behavioral economists, psycholinguists, behavioral biologists, neuroscientists, and even some statisticians. The objective in all these branches of behavioral and social science is the same: to describe and explain how and why humans think, feel, and behave as they do (Kimble, 1989).

For many purposes, it may not matter much whether we can distinguish among the various branches, but there are differences nonetheless. In experimental psychology, researchers *often* study human experiences in controlled laboratory settings. Social and organizational psychologists, particularly those trained in a psychology graduate program, frequently conduct experiments, but they can be performed either in a field environment or a lab setting. By contrast, sociologists are more likely to perform survey studies in the field. Nonetheless, behavioral and social scientists borrow from one another's storehouse of methods: Sociologists and some economists also conduct experiments, and some psychologists perform survey research. Though these researchers teach in different departments in colleges and universities, the boundary lines in behavioral and social science are by no means rigid. As one illustration, there is a project called TESS (Time-Sharing Experiments for the Social Sciences, funded by the National Science Foundation), which allows experimenters in the social sciences to compete for the opportunity to replicate their lab findings in large populations by using telephone and Internet-based survey interviews.

Some research questions seem especially suitable to experimental investigation in the lab and also have real-life applications. For example, in psychophysics (the study of the relationship between physical stimuli and our human experience of them), experimenters working in the lab discovered many years ago that the amount by which stimulus intensity must be increased to produce a just-noticeable change in the perception of the stimulus is a constant proportion of the intensity of the original stimulus. Following this line of *empirical investigation*, they showed that it is possible to write a mathematical statement of the theoretical relationship between the intensity of a stimulus and the intensity of a sensation, a statement that can then be applied to a range of real-life situations. If, say, your room is lighted by a 100-watt bulb, and if 15 watts of light must be added before you can just detect a difference in the amount of the light, then in a room with a 50-watt bulb, 7.5 watts must be added to make the difference detectable.

What Do Methodological Pluralism and Theoretical Ecumenism Connote?

The philosopher Hans Reichenbach noted how scientists, inspired by different ideas and often using different techniques, amass "concatenations of evidence" to explain things. This description applies as well to behavioral and social scientists. In many areas, research has evolved since the early 1970s to embrace what we describe as *methodological pluralism and theoretical ecumenism* (Jaeger & Rosnow, 1988; Rosnow, 1981, 1986; cf. Houts, Cook, & Shadish, 1986). By **methodological pluralism**, we mean that behavioral scientists frequently use more than one method to zero in on phenomena of interest, on the assumption that any single method is limited in some ways. Using multiple methods is a way of attempting to have one method's strengths compensate for another's limitations. The TESS project noted above is an example, in that it allows researchers to use large populations, thereby compensating for the small, highly select samples originally used in their lab experiments. By **theoretical ecumenism**, we mean there is often more than one "right way" to view the causes of behavior, because human nature is quite complex and behavior may be motivated by more than one cause or the pursuit of more than one objective. As scientists in different fields strive to develop a more complete and integrated picture of human behavior, we have begun to see more interdisciplinary research. Sometimes a whole new field is created. Familiar examples include behavioral medicine, psycholinguistics, and, perhaps most broadly, cognitive neuroscience.

Another prime example recently has been the application of psychological principles to the understanding of economic behavior. Psychologists Daniel Kahneman (who was awarded a Nobel Prize in economics in 2002) and his coworker for many years, the late Amos Tversky, did seminal research on how people commonly use information-processing rules of thumb (called *cognitive heuristics*) to quickly make judgments that not only defy logic but are often wrong (Kahneman & Tversky, 1973; Tversky & Kahneman, 1974). Later on in this book (Chapter 11), we refer to risk judgments, which show that laypeople frequently think things are more risky or less risky than experts do (Kahneman, Slovic, & Tversky, 1982). When people frame an event in their minds, they frequently make predictions and then behave in ways that are generally consistent with their expectations, such as overestimating the likelihood of a particular economic outcome merely because instances of it are salient at that moment. Previously, we mentioned the false consensus effect (Ross et al., 1977), which is another example of a cognitive heuristic (in this case, overestimating the extent to which others share your beliefs). Once people behave in accordance with their predictions, their predictions become what the sociologist Robert Merton (1948, 1968) called a *self-fulfilling prophecy* (we will refer to this term again). Thus, we see how hybrid branches of behavioral science grow creatively from new interdisciplinary ventures.

Other examples of the range of methodological pluralism in psychology were mentioned previously, including Galton's use of actuarial data to study the efficacy of prayer, Ceci et al.'s use of the "Sam Stone" manipulation to study children's eyewitness testimony, and Asch's laboratory simulation of conformity. But even a cursory glance at any of the hundreds of different journals in psychology will reveal that there are countless techniques of empirical inquiry. To create a general overview, we will lump together the orientations of behavioral and social research into three general types: descriptive, relational, and experimental. As you become better acquainted with the literature in your area of interest, you will see that the research usually involves more than one line of attack, although a given study can often be described as primarily one of these three in terms of its main orientation. Frequently, as illustrated next, the progression of empirical reasoning and research is from descriptive to relational to experimental.

How Does Research Go From Descriptive to Relational to Experimental?

In **descriptive research**, the goal of the investigation is the careful mapping out of a situation or a set of events, that is, a description of what is happening behaviorally. Causal explanations are not of direct concern except perhaps speculatively. For example, if we are interested in the study of children's failure in school, we might spend a good deal of time measuring and evaluating the classroom behavior of children who are doing poorly. We would then describe as carefully as possible what we have observed. Our careful observation of failing students might lead to some revision of traditional concepts of classroom failure, to suggestions about factors that contribute to the development of failure, and perhaps to speculative ideas for the remediation of failure.

This descriptive orientation is often considered a necessary first step in the development of a program of research because it establishes the foundation of any future undertaking. But it is rarely regarded as sufficient, because sooner or later someone will want to know *why* something happens or *how* what happens is related to other events. If our interest is in children's classroom failure, we are not likely to be satisfied for very long with even the most careful description of that failure. We will want to know the antecedents of the failure and the outcomes of procedures designed to reduce it. Even if we were not motivated directly by the practical implications of knowing the causes and cures of failure, we would believe our understanding to be considerably improved if we knew the conditions that increase and decrease its likelihood. To learn about the increase or decrease of failure, or any other behavior, we must focus on at least two variables at the same time. That is, we must make two sets of observations and assess the degree of relationship between the two sets.

At this point, the second broad type of approach, **relational research**, begins. Research is relational (or **correlational**) when two or more variables or conditions are measured and their degree of relationship to each other is estimated. As we continue with the classroom example, let us suppose we noted that the teachers of many of the failing students rarely looked at or addressed the students and seldom exposed them to new academic information. At this stage, we may have an impression about the relation between learning failure and teaching behavior. Such impressions are a frequent, and often valuable, by-product of descriptive research. If they are to be taken seriously, however, they cannot be left at the impressionistic level for very long.

Because we want to find out whether the researcher's impressions are accurate, we now arrange a series of coordinated observations on a sample of students who effectively represent the *target population* (i.e., the students to whom we would like to generalize our findings). We note whether or not each student in the sample has been learning anything or to what degree the student has been learning; we also note to what degree the teacher has been exposing the student to the material to be learned. From these coordinated observations, we should be able to make a quantitative statement concerning the relationship (or *degree of correlation*) between the amount of the student's exposure to the material to be learned and the amount of this material the student has in fact learned. We will then indicate not just (a) whether "*X* and *Y* are significantly related" (i.e., whether this nonzero relationship is unlikely to have occurred by chance alone), but also (b) the pattern of the relationship (e.g., linear or nonlinear) and (c) the strength of the relationship in terms of the size of the correlation between *X* and *Y*. (Later in this book, we will illustrate in a more precise way what these statistical terms mean.)

To carry the example into the third general approach, suppose that the students exposed to less information were also those who tended to learn less. The discovery of this relationship might tempt us to conclude that children learn less because they are taught less. Such an **ad hoc hypothesis** (a conjecture or supposition developed on the spot "for this" special result), although plausible, is not warranted by the relationship reported. It may be that teachers teach less to those they know to be less able to learn; that is, differences in teaching behavior may be a result of the students' learning as much as a determinant of that learning. To pursue this idea, we will need to make further observations that will allow us to infer whether differences in the information presented to the students, apart from any individual differences among them, affect their learning. We can best answer such questions by manipulating the conditions that we think are responsible for the effect. In other words, we introduce some change into the situation, or we interrupt or terminate the situation in order to identify causes.

This process is what is generally meant by the term **experimental research**, the objective of which is the identification of causes (i.e., what leads to what). Relational research only rarely provides such information, and then only under very special conditions. The difference between the degree of focus on a causal explanation in relational and experimental research can be expressed in the difference between the statements "*X* is *related* to *Y*" (relational research) and "*X* is *responsible* for *Y*"

BOX 1.4 Random Sampling and Random Assignment

Two important concepts that students new to research methods may find confusing are *random sampling* and *random assignment*. In the relational example, we described arranging for a series of observations on a sample of students who represented the target population. To increase the likelihood that the sample will be representative of the population, we use a **random sampling** procedure (the procedure used by professional survey researchers) to select the sample. In the experimental example just discussed, we described dividing a sample of students into two groups by tossing a coin to decide which condition each student would be assigned to. An unbiased randomizing procedure (a coin toss, for example) to allocate subjects to different conditions is called **random assignment** and is characteristic of *randomized experiments* (or *randomized trials,* the term that is commonly used to describe randomized experiments with new drugs in biomedical research). We will have more to say about these concepts and terms later in this book.

(experimental research). In our example, teaching is X and learning is Y. Our experiment will be designed to reveal the effects of teaching on student learning. We will select a sample of youngsters and, by tossing a coin, or by some other unbiased method of selection, randomly assign them to two groups (see Box 1.4). The teachers will give more information to one of these groups (the experimental group) and will give the other group (the control group) less information. We can then assess whether the experimental group surpassed the control group in learning achievement. If we find this to be true, we can say that giving the experimental group more information was *responsible* for the outcome.

There might still be a question of what it was about the better procedure that led to the improvement. Indeed, it is characteristic of research that, when a new procedure is shown to be effective, many questions arise about what elements of the procedure are producing the benefits. In the case of increased teaching, we may wonder whether the improvement was due to (a) the nature of the additional material; (b) the teacher's increased attention to the student while presenting the additional material; (c) any accompanying increases in eye contact, smiles, or warmth; or (d) other possible correlates of increased teaching behavior. These alternatives have been empirically investigated, and it has been observed that the amount of new material teachers present to their students is sometimes predictable not so much by the student's learning ability as by the teachers' beliefs or expectations about their students' learning ability. In other words, teachers' expectations about their students' performance sometimes becomes a self-fulfilling prophecy, in which teachers' expectations become responsible for their students' performance (Babad, 1993; Raudenbush, 1984; R. Rosenthal, 1966, 1976, 1985, 1991; R. Rosenthal & Jacobson, 1968; R. Rosenthal & Rubin, 1978).

As a final illustration of the distinction between descriptive, relational, and experimental research, Table 1.1 shows empirically grounded conclusions in psycholinguistics, the psychology of rumor, and research on a methodological issue. As you study these conclusions, you will see that descriptive research tells us

Table 1.1 Descriptive, Relational, and Experimental Conclusions in Three Research Areas

Psycholinguistics

Descriptive: When a 2-year-old child listens to a message spoken by his or her mother and is asked to repeat it, the child typically repeats only part of the message (R. Brown, 1965).
Relational: On the average, frequently used words tend to be shorter than infrequently used words; this statement is called *Zipf's law* (G. A. Miller & Newman, 1958; Zipf, 1935, 1949).
Experimental: When interfering background noise is present, a speaker tends to use more words and fewer abbreviations than when there is no interfering background noise (Heise & Miller, 1951).

Psychology of Rumor

Descriptive: In rumor chat groups on the Internet, the participants tend to adopt changing roles, described as the skeptical disbeliever, the positivist, the apprehensive believer, the curious, the anxious, the prudent initiator, and the investigator (Bordia & Rosnow, 1998). In network studies of rumors in organizations, it has been found that there are usually a few well-connected opinion leaders or liaisons who spread rumors (Hellweg, 1987).
Relational: In some circumstances, rumors forecasting unpleasant consequences are passed to others with greater frequency than rumors forecasting pleasant consequences (Rosnow, Esposito, & Gibney, 1987; C. J. Walker & Blaine, 1991).
Experimental: Children 3–5 years old who overheard a rumor were as likely to report that they had experienced the rumored, but not experienced, event as were children who actually experienced it (Principe, Kanaya, Ceci, & Singh, 2006).

Methodological Research

Descriptive: It has been estimated that perhaps 80% of psychological research on normal adults has used college and university students as research participants (Higbee & Wells, 1972; J. Jung, 1969; McNemar, 1946; Schultz, 1969; Sears, 1986; Sieber & Saks, 1989; Smart, 1966).
Relational: People who volunteer to participate in behavioral and social research are usually higher than nonvolunteers in education, social class, intelligence, and the need for social approval (Rosenthal & Rosnow, 1975b; Rosnow & Rosenthal, 1997).
Experimental: Research participants made to experience a conflict between "looking good" and cooperating with the experimenter are likely to try to look good, whereas participants not made to experience such a conflict are likely to help the experimenter (Rosnow, Goodstadt, Suls, & Gitter, 1973; Sigall, Aronson, & Van Hoose, 1970).

how things are; relational research tells us *how things are in relation to other things;* and experimental research tells us *how things are and how they got to be that way.*

What Are the Characteristics of Good Researchers?

Some people are better at what they do than others, whether students, teachers, spouses, parents, workers, and so on. This is no less true of researchers, many of whom excel in what they do. Judith A. Hall (1984), a Northeastern University psychology professor, observed that many textbooks are filled with guidelines for good research but rarely mention what makes a good researcher. We will end this chapter by borrowing her list and adding a little to it, because these characteristics should also serve you well in everyday life:

1. *Enthusiasm.* Being enthusiastic about what you do is contagious and self-motivating, whereas being apathetic can also sap the passion and zeal of everyone around you. This is also true in science. As a wise researcher, Edward C. Tolman (1959), astutely commented, "In the end, the only sure criterion is to have fun" (p. 152). He did not mean that the good researcher views science as just fun and games without any ethical or societal implications or consequences. What he meant was that for researchers who excel in what they do, choosing a topic, doing research, and analyzing and reporting the results are as absorbing and as much fun as any game that requires skill and concentration and that fills a person with enthusiasm.
2. *Open-mindedness.* It is also more satisfying to be with someone who is open-minded, listens to what you have to say, and, when responding, is reasonable rather than dogmatic or a know-it-all. The good researcher is open-minded because it is by experiencing the world with a keen, attentive, inquisitive, and open mind that scientists come to perceive the world in novel ways. Another characteristic of an open mind is the ability to learn from one's mistakes and from the sensible advice and keen insights of others.
3. *Common sense.* Common sense is a prized characteristic in every aspect of life. There is an old story about "the drunkard's search": A drunkard lost his house key and began searching for it under a street lamp although he had dropped the key some distance away. Asked why he didn't look where he had dropped it, he answered, "There is more light here." Much effort is lost when researchers fail to use common sense and instead look in a convenient place, rather than in the most likely place (the place where common sense would lead them), for the answers to their questions. Similarly, Hall (1984) mentioned that many students ask only whether their research plan is technically correct, not whether it makes good sense.
4. *Role-taking ability.* The ability to see things from others' viewpoints is crucial to success in a wide variety of situations. In behavioral and social research, it means being able to see your study from the viewpoint of the participants. It

also means seeing it from the viewpoint of the person who will evaluate it (in this case, the instructor who will grade it). For students who plan to present their results in a poster, role-taking ability means seeing it from the vantage point of those who will view the poster.

5. *Creativity and inventiveness.* The good researcher is creative and inventive, that is, adept at finding solutions to problems of financial resources, equipment, recruitment, research space, and scheduling participants. The good researcher responds appropriately in emergencies and, of course, raises interesting questions.
6. *Confidence in one's own judgment.* Since there is seldom only one right way to do things, as Hall (1984) also noted, "There is no inherent reason why you must do as others in a research tradition have done" (p. v). As another writer put it, "You have to believe that by the simple application of your own mind to the facts of experience, you can discover the truth—a little part of it anyway" (Regis, 1987, p. 209).
7. *Ability to communicate.* Given the provisional nature of scientific truths (Box 1.1), the end of one study may very well be the starting point for another study. Therefore, it is essential to be able to communicate clearly so that one's findings will be plain to others (Barrass, 1978). As Hall (1984) commented, "Research is not just the doing, it's the telling. If no one knows about your study, or if they can't figure out or remember your results, then you might as well never have done it" (p. vi).
8. *Care about details.* Being careful about details is another characteristic that can serve us well, because others know they can have confidence in our conscientiousness, thoroughness, and the accuracy of our work. The good researcher is always careful about details, whether preparing a poster for a meeting, a paper for a course, or an article for a scientific journal. It means keeping complete records, carefully organizing the data, copying and adding numbers correctly, stating facts accurately, and proofreading patiently.
9. *Integrity and honest scholarship.* Every good researcher knows that integrity and honesty are paramount. Because "rigged" experiments or the presentation of faked results undermines the basic respect for the literature on which the advancement of science depends, either one is devastating to science. It is the duty of all scientists to guard against dishonesty, and this responsibility is taken very seriously (e.g., American Association for the Advancement of Science, 1988; American Psychological Association, 1973, 1982; Bridgstock, 1982; Koshland, 1988; R. Rosenthal, 1994b). (As you think about ethical problems in research, you are also forced to confront your own moral presuppositions.)

Summary of Ideas

1. Five reasons for studying research methods are (a) to provide a richer appreciation of the information that science and technology bring to modern life; (b) to avoid falling prey to hucksters and imposters whose showy claims are counterfeit; (c) to learn information and skills that are transferable beyond the research setting; (d) to learn that scientific knowledge is relative and provisional (Box 1.1); and (f) to consider research as a career.

2. Peirce's four methods for the "fixation of belief" (the formation of strong beliefs) are (a) the *method of tenacity* (stubbornly and mindlessly clinging to myth, folklore, and superstition, like believing in UFOs or the geocentric design; Box 1.2); (b) the *method of authority* (complying with the word of authority, like Peirce's witchcraft example on the negative side or, on the positive side, obeying reasonable laws that are the basis of civilized society); (c) the *a priori method* (the use of reason and logic to make sense of things and debunk hoaxes); and (d) the *scientific method*.
3. The *scientific method* is a misnomer, in that it is not a single, fixed method but is an approach that depends heavily on *empirical reasoning* (a combination of logic and the use of careful observation and measurement that is accessible to other researchers, e.g., Galton's study of prayer, Ceci's experimental study of children's eyewitness testimony, Asch's use of accomplices in his experimental study of whether a person will conform with a false consensus, and the early example in Box 1.3).
4. One illustration of how empirical methods are limited is that universal laws are based partly on a leap of faith because we simply cannot observe everything (e.g., that objects in motion will stay in motion forever).
5. Three extraempirical factors are (a) the beauty or elegance (the *aesthetic aspect*) of science (e.g., Einstein's general theory of relativity); (b) visualizations in the form of analogies and metaphors to make complex ideas more digestible; and (c) the informative and persuasive language (the *rhetoric of justification*) of science, which takes the form of written reports that conform to an accepted basic structure (illustrated in Appendix A).
6. *Behavioral science* comprises a variety of different fields, which enlist the use of multiple methods and theories (called *methodological pluralism* and *theoretical ecumenism*) to explain things by zeroing in (converging) on phenomena of interest. These fields are concerned with how and why people behave, feel, and think as they do.
7. *Descriptive research* tells us "how things are" (e.g., describes children's failure in school; other examples are given in Table 1.1).
8. *Relational research* tells us "how things are in relation to other things" (e.g., describes the relation between student failure and teaching behavior; see other examples in Table 1.1).
9. *Experimental research* tells us "how things are and how they got to be that way" (e.g., in studying the effects of teaching on student learning by manipulating the hypothesized causes of student failure; see other examples in Table 1.1).
10. *Random sampling* refers to choosing an unbiased sample that is representative of a targeted population, whereas *random assignment* refers to how subjects are allocated by an unbiased procedure to different groups or conditions in a randomized experiment (Box 1.4).
11. J. A. Hall listed nine traits of good researchers: enthusiasm, open-mindedness, common sense, role-taking ability, a combination of creativity and inventiveness, confidence in one's own judgment, the ability to communicate, care about details, and integrity and honest scholarship.

Key Terms

ad hoc hypothesis p. 15
aesthetic aspect of science p. 10
a priori method p. 6
behavior p. 12
behavioral science p. 12
correlational research p. 15
descriptive research p. 14
empirical p. 6
empirical reasoning p. 7
experimental research p. 15
method of authority p. 5
method of tenacity p. 4
methodological pluralism p. 13
perceptibility p. 10
random assignment p. 16
random sampling p. 16
relational research p. 15
rhetoric of justification p. 11
scientific method p. 1
theoretical ecumenism p. 13

Multiple-Choice Questions for Review (answers appear at the end of this chapter)

1. John believes that women are more emotionally expressive than men. When asked why he believes this, John says it is because he has "always" believed it, and because "everybody knows it is true." John is using the (a) method of tenacity; (b) scientific method; (c) a priori method; (d) method of authority.
2. Miles, a student at California State University at Sacramento, tells another student, Sasha, that "numbers are infinite," to which she responds, "Prove it!" Miles says, "Would you agree that any number doubled will result in a new number twice the size?" When Sasha answers "yes," Miles responds, "Aha, you have just proved that numbers are infinite, because there must be a limitless number of numbers if you are correct." Miles is using the (a) method of tenacity; (b) scientific method; (c) a priori method; (d) method of authority.
3. Julie believes that everyone dreams every night, because her psychology professor told her this is true. Julie is using the (a) method of tenacity; (b) scientific method; (c) a priori method; (d) method of authority.
4. Dr. Smith believes that psychotherapy is generally very effective in treating mental disorders. She claims that her belief is based on empirical research in which therapy was given to some patients but not others, and in which the degree of mental disorder was carefully measured. Dr. Smith's belief is based on the (a) method of tenacity; (b) scientific method; (c) a priori method; (d) method of authority.
5. Which of the following is the *most* distinctive characteristic of science? (a) empirical inquiry and empirical reasoning; (b) images and metaphors; (c) the rhetoric of science; (d) statistical explanation
6. Behavioral science (a) encompasses many scientific fields that study behavior; (b) emphasizes multiple methods of observation and explanation; (c) has seen a growth in the number of interdisciplinary fields; (d) all of the above.
7. Which empirical approach is often considered a necessary first step in conducting research but is rarely considered sufficient by itself? (a) relational research; (b) experimental research; (c) descriptive research; (d) none of the above
8. A researcher at the College of the Southwest conducts a research project on the study habits of students. She reports that, on average, college students study 20 hours per week. This is an example of (a) relational research; (b) experimental research; (c) descriptive research; (d) none of the above.
9. Experimental research (a) can support cause-effect conclusions; (b) involves the manipulation of variables; (c) often involves randomly assigning subjects to conditions; (d) all of the above.
10. A researcher at Grand Valley State University flips a coin to decide whether each person in a sample of research participants will be assigned to the experimental group or the control group. This is an illustration of (a) random sampling; (b) random assignment; (c) both random assignment and randomization because they are synonyms; (d) none of the above.

Discussion Questions for Review (answers appear at the end of this chapter)

1. Philosopher Charles Sanders Peirce described four distinctive approaches (he called them *methods*) on which strongly held beliefs are based. What are these "methods"? Give an example of a belief based on each method.
2. In addition to the use of empirical observation, three other (extraempirical) factors were said to play a role in science. What are those factors? Which of the four is traditionally considered "more fundamental" than the others in science?

3. A Wayne State researcher is interested in the effects of children's viewing TV violence on the children's level of aggression on the playground. The amount and type of viewing will be assessed through a standard procedure: TV diaries sent to parents. Aggression will be rated by two judges. The researcher hypothesizes that children who spend more time watching violent TV at home are more aggressive on the playground than their peers who watch relatively little violent TV at home. Of the three general research types (descriptive, relational, and experimental), which type is this, and why?
4. A Wichita State researcher plans to assign fifth-grade children to one of two conditions. Half the children (Group A) will be shown a relatively violent movie at 10:30, and half (Group B) will be shown a nonviolent movie at the same time. Each film will be equally engaging. Two observers will code the children's behavior when both groups are brought back together on the playground for their 11:00 recess. This procedure will continue daily for six weeks. The researcher predicts that Group A will be more aggressive on the playground than Group B. Which type of research is this, and why?
5. A researcher at the University of New Hampshire wants to measure the prevalence of shyness in the undergraduate community. She administers the well-standardized Shyness Scale to volunteers in a main dining hall, collecting data on a respectable 35% of all undergraduates. Which type of research is this, and why?
6. A North Dakota State student wants to study other students' creativity, and he wants to use all three types of research approaches (descriptive, relational, and experimental) in this project. Think of a concrete example of each type that he could use.
7. A student at Foothill College claims that it is not possible to study such nonscientific concepts as prayer because prayer falls in the domain of theology rather than of science. Is the student correct?
8. Alan Turing, who conceived of the computer and was also primarily responsible for breaking the German code (called Enigma) during World War II, proposed a way of demonstrating that a computer simulation of human intelligence actually works. Called the *Turing test,* it consists of people having a dialogue with the computer and seeing whether the computer can fool them into thinking that they are interacting with a human being. How is this an example of empirical reasoning?
9. The chapter ended by describing psychologist Judith Hall's nine "traits of good researchers." List as many as you can recall.

Answers to Review Questions

Multiple-Choice Questions

1. a	**3.** d	**5.** a	**7.** c	**9.** d
2. c	**4.** b	**6.** d	**8.** c	**10.** b

Discussion Questions

1. First, the method of tenacity: believing something because it is an idea that has been around for a long time (e.g., Elvis is alive). Second, the method of authority: believing something said by an expert in the field (e.g., cutting back on fatty foods because the doctor told you to do so and you believe doctors know about this). Third, the a priori method: using pure reason as a basis of belief (e.g., reasoning that $12 \times 100 = 120 \times 10 = 1 \times 1200$). Fourth, the scientific method: using empirical reasoning as a basis of belief (e.g., believing the earth is round because you have circled the globe by foot, boat, and vehicle and not fallen off).
2. The three *extraempirical* factors are aesthetics (the beauty of science), perceptibility (the use of images and metaphors), and rhetoric (the technical concepts and persuasive *language* used in

science). Empirical reasoning and empirical methods are considered the "most fundamental" in science.

3. This is relational research because the relationship between two sets of observations (TV diary entries and playground aggression) is examined. It is not experimental because neither of the variables is manipulated by the investigator.
4. This is experimental research because the investigator has manipulated the type of movie shown.
5. This is descriptive research because the data are collected on student shyness, but these scores are not examined for their relationship with any other variable.
6. For his descriptive research, he might collect data on the creativity scores of other students. For his relational research, he might examine the relationship between creativity scores and SAT (Scholastic Assessment Test) scores. For his experimental research, he might experimentally manipulate the type of music being played in the background while the students' creativity is being measured to see whether Mozart makes students more creative than does hard rock.
7. No, it certainly *is* possible to study the concept of prayer, and Galton conducted a relational study of prayer and longevity. An experimental study might use prayer for a randomly chosen half of 50 people who are ill and no prayer for the remaining people to see whether prayer brings about faster recovery.
8. It is an example of empirical reasoning because it involves logic, observation, and even a kind of measurement. The logic is Turing's reasoning that it may be possible for a computer to trick a person into mistaking it for a human being. The observation is the test itself, and the kind of measurement might consist of judgments made by people at different points in their interaction with the computer, and then a final judgment about whether they were interacting with a person or a computer.
9. The nine traits are (a) being enthusiastic about the topic and process of research; (b) being open-minded so as not to miss a promising lead, and so as to learn from your mistakes and others' criticisms; (c) using good sense rather than doing something only because it is convenient; (d) taking the role of the research participant, the person who grades your paper, and, if you are presenting a poster, the poster's viewers; (e) being inventive and creative during the planning and implementation of your research and in asking interesting questions; (f) having confidence in your own judgment after applying your mind to the facts; (g) learning to communicate clearly; (h) being careful about details in all phases of your research; and (i) being honest in every aspect of the research.