Explaining Behavior

CHAPTER OUTLINE

On September 21, 2008, after a day of playing basketball with his friends, 14-year-old Christopher Cepeda and four of his buddies began their journey home on foot. Along the way they came to a busy stretch of Highway 27, where a grassy median separated four lanes of traffic that sped by at 65 mph. The boys made it safely across the two northbound lanes and, upon seeing a tan, 1998 Buick sedan approaching in the southbound lane, they paused in the median. Christopher, distracted as he typed out a text message on his cell phone, never saw the car and stepped out into its path. The car struck the young teenager, throwing him into the windshield and then onto the pavement. In spite of the quick response from local emergency crews, Christopher succumbed to his injuries.

A number of states have enacted laws banning the practice of texting while driving. Studies have demonstrated that texting while driving results in a degradation of driving skills (e.g., Drews, Pasupathi, & Strayer, 2008). Attention has now shifted to the problem of "distracted walking." This occurs when a person is so engrossed in doing something on a cell phone that the distracted person fails to identify potentially dangerous conditions. Sometimes the consequences of walking while using a cell phone are harmless, even funny. For example, a video posted on YouTube shows a young woman walking in a mall who is so engrossed in her cell phone that she doesn't notice a fountain and falls right into it. We can all laugh at the poor woman's fate, knowing that she was not seriously hurt. However, as in the case of Christopher Cepeda, distracted walking can have tragic consequences.

It seems obvious why texting while walking may lead to accidents: Distracted by the task of reading or composing messages, the person fails to notice potential dangers such as obstacles in the pathway or oncoming vehicles. Yet, most of the time, we somehow manage to engage in a variety of activities while walking—including interacting with a cell phone—without suffering nasty consequences.

Why does cell phone use while walking sometimes lead to accidents but more often does not? Attempting to answer this question, we could engage in endless speculation. Is it simply a matter of chance? Do some individuals become more absorbed in their activities on the cell phone than others and thus become less likely to notice a potential danger? Does the specific activity on the phone matter (e.g., texting as opposed to talking)? Are drugs and alcohol a factor?

Questions such as these almost cry out for answers. This is where science and scientists come in. Whereas most of us content ourselves with answers that merely *seem* reasonable, scientists go well beyond mere speculation: They formulate ways to determine clearly the relationship between such factors and one's ability to walk safely while interacting on a cell phone and then design research studies to test those relationships.

This book is about how the initial curiosity sparked by an event such as the Cepeda accident gets transformed into a testable research question and eventually into a research study yielding data that are analyzed. Only through this process can we move beyond dinner table speculations and into the realm of scientific explanation.

WHAT IS SCIENCE, AND WHAT DO SCIENTISTS DO?

The terms *science* and *scientist* probably conjure up a variety of images in your mind. A common image is that of a person in a white lab coat surrounded by bubbling flasks and test tubes, working diligently to discover a cure for some dreaded disease. Alternatively, our lab-coated scientist might be involved in some evil endeavor that will threaten humankind. Books, movies, and television have provided such images. Just think about the classic horror films of the 1940s and 1950s (e.g., *Frankenstein*), and it is not hard to see where some of these images come from.

Although these images may be entertaining, they do not accurately capture what science actually is and what real scientists do. Simply put, **science** is a set of methods used to collect information about phenomena in a particular area of interest and build a reliable base of knowledge about them. This knowledge is acquired via *research*, which involves a scientist identifying a phenomenon to study, developing hypotheses, conducting a study to collect data, analyzing the data, and disseminating the results. Science also involves developing theories to help better describe, explain, and organize scientific information that is collected. At the heart of any science (psychology included) is information that is obtained through observation and measurement of phenomena. So, for example, if I want to know if text messaging while walking is a serious threat to safety, I must go out and make relevant observations. Science also requires that any explanations for phenomena can be modified and corrected if new information becomes available. Nothing in science is taken as an absolute truth. And, regardless of what you may have seen in the media, there is no such thing as "settled science." All scientific observations, conclusions, and theories are *always* open to modification and perhaps even abandonment as new evidence arises.

Of course, a **scientist** is someone who does science. A scientist is a person who adopts the methods of science in his or her quest for knowledge. However, this simple definition does not capture what scientists do. Despite the stereotyped image of the scientist hunkered over bubbling flasks, scientists engage in a wide range of activities designed to acquire knowledge in their fields. These activities take place in a variety of settings and for a variety of reasons. For example, you have scientists who work for pharmaceutical companies trying to discover new medications for the diseases that afflict humans. You have scientists who brave the bitter cold of the Arctic to take ice samples that they can use to track the course of global climate change. You have scientists who sit in observatories with their telescopes pointed to the heavens, searching for and classifying celestial bodies. You have scientists who sit for hours in carefully constructed blinds observing and recording the natural behavior of animals in the wild. You have scientists who work at universities and conduct studies to acquire knowledge in their chosen fields (e.g., psychology, biology, or physics). In short, science is a diverse activity involving a diverse group of people doing a wide range of things. Despite these differences, all scientists have a common goal: to acquire knowledge through the application of scientific methods and techniques.

Science as a Way of Thinking

It is important for you to understand that science is not just a means of acquiring knowledge; it is also a way of thinking and of viewing the world. A scientist approaches a problem by carefully defining its parameters, seeking out relevant information, and subjecting proposed solutions to rigorous testing. The scientific view of the world leads a person to be skeptical about what he or she reads or hears in the popular media. Having a scientific outlook leads a person to question the validity of provocative statements made in the media and to find out what scientific studies say about those statements. In short, an individual with a scientific outlook does not accept everything at face value.

Let's see how thinking like a scientist might be applied. Imagine that you are having difficulty relaxing while taking important exams, resulting in poor performance. One night while watching television you see an advertisement for something that might help you relax. According to the advertisement, a new extract of lavender has been discovered that, when inhaled, will help you relax. There are several testimonials from users of the product to back up the claims made in the ad. The question is whether to shell out the money for the lavender scent.

A person who is *not* thinking like a scientist will pull out a credit card and place the order. A person who *is* thinking like a scientist will question the validity of the claims made in the ad and make an effort to find out whether the lavender scent will in fact reduce stress and improve performance. This involves taking the time and making the effort to track down relevant research on the effectiveness of aromatherapy, specifically the effects of lavender scent on stress. Imagine you do a quick literature search and find an article by Howard and Hughes (2008) that tested the effect of a lavender scent against a placebo scent (a scent without any purported therapeutic value) and against no scent on stress responses. Howard and Hughes, you discover, found that scents had no effect on stress unless participants were specifically led to expect the scents to have an effect. In short, the effect of the lavender scent could be explained by expectation effects. So, you decide to save your money.

This is but one example of how thinking like a scientist leads one to question a claim and look for *empirical evidence*—evidence based on observation or experimentation—to verify that claim. There are many other situations where thinking like a scientist can better allow you to evaluate the validity of a claim or a conclusion. For example, during an election year we are bombarded with poll after poll about candidates and who is in the lead. Rather than accepting on face value that candidate X has a lead over candidate Y, you should obtain a copy of the actual survey results (often available online at the pollster's website), and then look at the sample employed and how the questions were worded. As we will see in later chapters, biased samples and question wording can affect the validity of survey findings.

How Do Scientists Do Science?

In their quest for knowledge about a phenomenon, scientists can use a wide variety of techniques, each suited to a particular purpose. Take the question about using a cell phone while walking. You, as a scientist, could approach this issue in several ways. For example, you could examine health records on injuries incurred while talking on a cell phone during walking. You would then examine your data to see if there is a relationship between using a cell phone and being injured while walking. If you found that there was a greater frequency of accidents when using a cell phone, this would verify the role of cell phones in pedestrian accident injuries.

Another way you could approach this problem is to conduct a controlled experiment. You could have participants navigate through a controlled environment while either using or not using a cell phone. If you find that participants bump into more objects when using a cell phone, you would have verified the effects of distracted walking on accidents.

QUESTIONS TO PONDER

1. What is science, and what do scientists do?
2. What is meant by the statement that science is a way of thinking? (Explain.)
3. How do scientists obtain knowledge on issues that interest them?

Basic and Applied Research

Scientists work in a variety of areas to identify phenomena and develop valid explanations for them. The goals established by scientists working within a given field of research may vary according to the nature of the research problem being considered. For example, the goal of some scientists is to discover general laws that explain particular classes of behaviors. In the course of developing those laws, psychologists study behavior in specific situations and attempt to isolate the variables affecting behavior. Other scientists within the field are more interested in tackling practical problems than in finding general laws. For example, they might be interested in determining which of several therapy techniques is best for treating severe phobias.

An important distinction has been made between basic research and applied research along the lines just presented.

Basic Research **Basic research** is conducted to investigate issues relevant to the confirmation or disconfirmation of theoretical or empirical positions. The major goal of basic research is to acquire general information about a phenomenon, with little emphasis placed on applications to real-world examples of the phenomenon (Yaremko, Harari, Harrison, & Lynn, 1982). For example, research on the memory process may be conducted to test the efficacy of interference as a viable theory of forgetting. The researcher would be interested in discovering something about the forgetting process while testing the validity of a theoretical position. Applying the results to forgetting in a real-world situation would be of less immediate interest.

Applied Research The focus of **applied research** is somewhat different from that of basic research. Although you may still work from a theory when formulating your hypotheses, your primary goal is to generate information that can be applied directly to a real-world problem. A study by Jodi Quas and her colleagues (2007) provides a nice example of an applied study. In a number of criminal and civil trials, children may be called to testify about something (such as abuse) that may have happened to them. One concern is that children's memories may not be as accurate as adult memories or that it may be easier to implant memories into children than adults. Quas et al. investigated a number of factors that can affect the accuracy of children's memory. They found that children who were interviewed multiple times about an event that never occurred showed greater memory accuracy and less susceptibility to suggestion than children interviewed once. Results such as these can help law enforcement officers design interviews for children that will maximize memory accuracy. Further examples of applied research can be found in the areas of clinical, environmental, and industrial psychology (among others).

Overlap Between Basic and Applied Research The distinction between applied and basic research is not always clear. Some research areas have both basic and applied aspects. The Quas et al. study provides a good example of research that has both applied and basic implications. Their results can inform law enforcement personnel and others who may have to interview young children how to best approach the interview process. In addition to these applied implications, this research has basic implications as well because the results tell us something about developmental changes in how memory works and the factors that affect memory accuracy.

Even applied research is not independent of theories and other research in psychology. The defining quality of applied research is that the researcher attempts to conduct a study the results of which can be applied directly to a real-world event. To accomplish this task, you must choose a research strategy that maximizes the applicability of findings.

Framing a Problem in Scientific Terms

Kelly (1963) characterized each person as a scientist who develops a set of strategies for determining the causes of behavior observed. We humans are curious about our world and like to have explanations for the things that happen to us and others. After reading about Christopher Cepeda's accident, you may have thought about potential explanations for the accident. For example, you might have questioned whether using a cell phone while walking is uniquely distracting compared to other distractions (e.g., talking with friends).

exposed to science. When you hear about a new cure for a disease, you are being exposed to science. When you are persuaded to buy one product over another, you are being exposed to science. Science, on one level or another, permeates our everyday lives. To deal rationally with your world, you must be able to analyze critically the information thrown at you and separate scientifically verified facts from unverified conjecture.

Often, popular media such as television news programs present segments that *appear* scientific but on further scrutiny turn out to be flawed. One example was a segment on the ABC television news show *20/20* on sexual functions in women after a hysterectomy. In the segment, three women discussed their post-hysterectomy sexual dysfunction. One woman reported, "It got to the point where I couldn't have sex. I mean, it was so painful . . . we couldn't do it." The testimonials of the three patients were backed up by a number of medical experts who discussed the link between hysterectomy and sexual dysfunction.

Had you watched this segment and looked no further, you would have come away with the impression that post-hysterectomy sexual dysfunction is common. After all, all the women interviewed experienced it, and the experts supported them. However, your impression would not be correct. When we examine the research on post-hysterectomy sexual functioning, the picture is not nearly as clear as the one portrayed in the *20/20* segment. In fact, there are studies showing that after hysterectomy, women may report an *improvement* in sexual function (Rhodes, Kjerulff, Langenberg, & Guzinski, 1999). Other studies show that the type of hysterectomy a woman has undergone makes a difference. If the surgery involves removing the cervix (a total hysterectomy), there is more sexual dysfunction after surgery than if the cervix is left intact (Saini, Kuczynski, Gretz, & Sills, 2002). Finally, the Boston University School of Medicine's Institute for Sexual Medicine reports that of 1,200 women seen at its Center for Sexual Medicine, very few of them complained of post-hysterectomy sexual dysfunction (Goldstein, 2003).

As this examples suggests, whether you plan a career in research or not, it is to your benefit to learn how research is done. This will put you in a position to evaluate information that you encounter that is supposedly based on "science."

EXPLORING THE CAUSES OF BEHAVIOR

Psychology is the science of behavior and mental processes. The major goals of psychology are (1) to build an organized body of knowledge about its subject matter and (2) to describe mental and behavioral processes and develop reliable explanations for these processes. For example, psychologists interested in aggression and the media would build a storehouse of knowledge concerning how various types of media violence (e.g., movies, television shows, cartoons, or violent video games) affect aggressive behavior. If it were shown that exposure to violence in the media increases aggression, the psychologist would seek to explain how this occurs.

How do you, as a scientist, go about adding to this storehouse of knowledge? The principal method for acquiring knowledge and uncovering causes of behavior is *research*. You identify a problem and then systematically set out to collect information about the problem and develop explanations.

Robert Cialdini (1994) offers a simple yet effective analogy to describe the process of studying behavior: He likens science to a hunting trip. Before you go out to "bag" your prey, you must first scout out the area within which you are going to hunt. On a hunting trip, scouting involves determining the type and number of prey available in an area. Cialdini suggests that in science "scouting" involves making systematic observations of naturally occurring behavior.

Sometimes scouting may not be necessary. Sometimes the prey falls right into your lap without you having to go out and find it. Cialdini tells a story of a young woman who was soliciting for a charity. Initially, Cialdini declined to give a donation. However, after the young woman told him that "even a penny would help," he found himself digging into his wallet. As he reflected on this experience, he got to wondering why he gave a donation after the "even a penny would help" statement. This led him to a series of studies on the dynamics of compliance. In a similar manner, as you read about the Christopher Cepeda case, you might already have begun to wonder about the factors that contribute to distraction-related accidents. As we describe in Chapter 3, "scouting" can involve considering many sources.

The second step that Cialdini identifies is "trapping." After you have identified a problem that interests you, the next thing to do is identify the factors that might affect the behavior that you have scouted. Then, much like a hunter closing in on prey, you systematically study the phenomenon and identify the factors that are crucial to explaining that phenomenon. For example, after wondering whether talking on a cell phone while walking causes accidents, you could set up an experiment to test this. You could have participants walk through a building over a predesignated route. Participants in one condition would walk through the building while talking on a cell phone, and participants in another would do the task without talking on a cell phone. You could record the number of times a participant bumps into objects while walking through the building. If you find that participants talking on a cell phone bump into more objects than those not talking on a cell phone, you have evidence that talking on a cell phone while walking causes pedestrians to make more potentially dangerous errors while walking.

QUESTIONS TO PONDER

1. How do basic and applied research differ, and how are they similar?
2. How are problems framed in research terms?
3. What is confirmation bias, and what are its implications for understanding behavior?
4. Why should you care about learning about research, even if you are not planning a career in research?
5. What are the two steps suggested by Cialdini (1994) for exploring the causes of behavior, and how do they relate to explaining behavior?

EXPLAINING BEHAVIOR

Imagine that, after narrowly avoiding being hit by a car when you stepped into an intersection while texting on your phone, you find yourself depressed, unable to sleep, and lacking appetite. After a few weeks of feeling miserable, you find a therapist whom you have heard can help alleviate your symptoms. On the day of your appointment you meet with your new therapist. You begin by mapping out a therapy plan with your therapist. You and she identify stressful events you have experienced, current situations that are distressing to you, and events in your past that might relate to your current symptoms. Next you identify an incident that is causing you the most distress (in this case, your near-accident) and your therapist has you visualize things relating to your memory of the event. She also has you try to reexperience the sensations and emotions related to the accident.

So far you are pretty satisfied with your therapy session because your therapist is using techniques you have read about and that are successful in relieving symptoms like yours. What occurs next, however, puzzles you. Your therapist has you follow her finger with your eyes as she moves it rapidly back and forth across your field of vision. Suddenly, she stops and tells you to let your mind go blank and attend to any thoughts, feelings, or sensations that come to mind. You are starting to wonder just what is going on. Whatever you come up with, your therapist tells you to visualize and has you follow her finger once again with your eyes. On your way home after the session you wonder just what the finger exercise was all about.

When you get home, you do some research on the Internet and find that your therapist was using a technique called Eye Movement Desensitization and Reprocessing (EMDR) therapy. You read that the eye movements are supposed to reduce the patient's symptoms rapidly. Because you did not experience this, you decide to look into what is known about EMDR therapy. What you find surprises you. You find a number of websites touting the effectiveness of EMDR. You read testimonials from therapists and patients claiming major successes using the treatment. You also learn that many clinical psychologists doubt that the eye movements are a necessary component of the therapy. In response, advocates of EMDR have challenged critics to prove that EMDR does not work. They suggest that those testing EMDR are not properly trained in the technique, so it will not work for them. They also suggest that the eye movements are not necessary and that other forms of stimulation, such as the therapist tapping her fingers on the client's leg, will work. You are becoming skeptical. What you want to find is some real scientific evidence concerning EMDR.

Science, Protoscience, Nonscience, and Pseudoscience

We have noted that one goal of science is to develop explanations for behavior. This goal is shared by other disciplines as well. For example, historians may attempt to explain why Robert E. Lee ordered Pickett's Charge on the final day of the Battle of Gettysburg. Any explanation would be based on reading and interpreting historical documents and records. However, unless such explanations can be submitted to empirical testing, they are not considered scientific.

What distinguishes a true established science from protoscience, nonscience, and pseudoscience? The difference lies in the methods used to collect information and draw conclusions from it. A true, established science relies on established scientific methods to acquire information and adheres to certain rules when determining the validity of information acquired.

Protoscience is a term given to science at the edges of current scientific understanding (Sohl, 2004). Sometimes this form of science is called "fringe science" because it deals with issues and phenomena at the fringes of established science (Sohl, 2004). Protosciences often use the scientific method to test ideas. According to Sohl, protoscience has the potential to develop into true science if the phenomena being studied receive legitimate scientific support; this happened in areas such as computer science and epigenetics. On the other hand, protoscience can descend into pseudoscience if claims made cannot be empirically verified. In yet other cases, not enough evidence is available to establish a field as scientific. For example, after actor Christopher Reeve suffered a spinal injury that left him paralyzed from the neck down, new treatments were being explored in which spinal cord patients exercised paralyzed limbs on special equipment. Many of these patients showed recovery of some sensory and/or motor functions. However, to be considered scientifically valid, the efficacy of this therapy, while potentially exciting for patients, must be verified via carefully conducted studies. A recent review of existing studies suggests that exercise can improve muscle tone and improve existing capabilities (Lu, Battistuzzo, Zoghi, & Galea, 2015). However, there is little evidence that exercise can help spinal patients recover lost functions (Hicks et al., 2011). Although there are instances where protoscience has advanced to the status of true science, there are others where seemingly scientific areas descended into the realm of pseudoscience (e.g., alchemy and astrology).

A *nonscience* can be a legitimate academic discipline (like philosophy) that applies systematic techniques to the acquisition of information. For example, philosophers may differ on what they consider to be ethical behavior and may support their positions through logical argument. However, they lack any empirical test through which one view or another might be supported, and so the question of what is ethical cannot be addressed through scientific means.

Pseudoscience is another animal altogether. The term **pseudoscience** literally means "false science." According to Robert Carroll (2006), "pseudoscience is [a] set of ideas based on theories put forth as scientific when they are not scientific" (http://skepdic.com/pseudosc.html). It is important to note that true science and pseudoscience differ more in degree than in kind, with blurred boundaries between them (Lilienfeld, Lynn, & Lohr, 2003). What this means is that science and pseudoscience share many characteristics. For example, both may attempt to provide support for an idea. However, the methods of pseudoscience do not have the same rigor or standards required of a true science. Some notorious examples of pseudoscience include phrenology (determining personality by reading the bumps on one's head), eye movement desensitization and reprocessing therapy (EMDR—moving one's eyes back and forth rapidly while thinking about a problem), and astrology (using the position of the stars and planets to explain behavior and predict the future).

Scott Lilienfeld (2005) lists several qualities that define a pseudoscience:

- Using situation specific hypotheses to explain away falsification of a pseudoscientific idea or claim;
- Having no mechanisms for self-correction and consequent stagnation of ideas or claims;
- Relying on confirming one's beliefs rather than disconfirming them;
- Shifting the burden of proof to skeptics and critics away from the proponent of an idea or a claim;
- Relying on nonscientific anecdotal evidence and testimonials to support an idea or claim;
- Avoiding the peer review process that would scientifically evaluate ideas and claims;
- Failing to build on an existing base of scientific knowledge;
- Using impressive-sounding jargon that lends false credibility to ideas and claims;
- Failing to specify conditions under which ideas or claims would not hold true.

Lilienfeld points out that no one criterion from this list is sufficient to classify an idea or claim as pseudoscientific. However, the greater the number of the aforementioned qualities an idea or claim possesses, the more confident you can be that the idea or claim is based on pseudoscience and not legitimate science.

Rory Coker (2007) provides a nice contrast between a true science and a pseudoscience. He identifies several crucial differences between science and pseudoscience that can help you assess whether an idea or claim is truly scientific or based on pseudoscientific beliefs. This contrast is shown in Table 1-1. Coker also suggests several additional characteristics of pseudoscience. First, pseudoscience often is unconcerned with facts and "spouts" dubious facts when necessary. Second, what research is conducted on an idea or claim is usually sloppy and does not include independent investigations to check its sources. Third, pseudoscience inevitably defaults to absurd explanations when pressed for an explanation of an idea or claim. Fourth, by leaving out critical facts pseudoscience creates mysteries that are difficult to solve. You can find a full list of these and other characteristics of pseudoscience at www.quackwatch.org/01QuackeryRelatedTopics/pseudo.html.

One area in which pseudoscience has become a concern is in the treatment of mental and behavioral disorders (Lilienfeld, 2015). There is ample evidence that evidence-based treatments have a significant, positive effect on treating disorders. For example, there is considerable scientific support for the success of cognitive-behavioral therapy (Lee & Hunsley, 2015). However, throughout the history of psychiatry and clinical psychology, there have been numerous treatments based on little empirical evidence or on pseudoscience, such as gluten-free diets to treat autism spectrum disorders (Lilienfeld, 2015). Now, you might be thinking what harm is there in trying such treatments? If it helps one child with autism, isn't it worth it? Lilienfeld points out that there are two liabilities in adopting treatments based on pseudoscience. First, such treatments may actually cause more harm than good. Lilienfeld gives the example of

TABLE 1-1 Distinguishing Science from Pseudoscience

SCIENCE	PSEUDOSCIENCE
Findings published in peer-reviewed publications using standards for honesty and accuracy aimed at scientists.	Findings disseminated to general public via sources that are not peer reviewed. No prepublication review for precision or accuracy.
Experiments must be precisely described and be reproducible. Reliable results are demanded.	Studies, if any, are vaguely defined and cannot be reproduced easily. Results cannot be reproduced
Scientific failures are carefully scrutinized and studied for reasons for failure.	Failures are ignored, minimized, explained away, rationalized, or hidden.
Over time and continued research, more and more is learned about scientific phenomena.	No underlying mechanisms are identified and no new research is done. No progress is made and nothing concrete is learned.
Idiosyncratic findings and blunders "average out" and do not affect the actual phenomenon under study.	Idiosyncratic findings and blunders provide the only identifiable phenomena.
Scientists convince others based on evidence and research findings, making the best case permitted by existing data. Old ideas discarded in the light of new evidence.	Attempts to convince based on belief and faith rather than facts. Belief encouraged in spite of facts, not because of them. Ideas never discarded, regardless of the evidence.
Scientist has no personal stake in a specific outcome of a study.	Serious conflicts of interest. Pseudoscientist makes his or her living off of pseudoscientific products or services.

SOURCE: Coker, 2007, https://webspace.utexas.edu/cokerwr/www/index.html/distinguish.htm

"scared straight" programs, which exposed youthful offenders to harsh prison environments. According to Lilienfeld, research evidence suggests that such programs can actually lead to more crime. Second, the time and energy devoted to poorly supported treatments sap valuable resources that could be better directed toward treatments that are more effective. The bottom line is that relying on information and treatments that do not have a solid foundation in science can be dangerous.

Scientific Explanations

Contrast pseudoscience with how a true science operates. A true science attempts to develop scientific explanations to explain phenomena within its domain. Simply put, a **scientific explanation** is an explanation based on the application of accepted scientific methods. Scientific explanations differ in several important ways from nonscientific and pseudoscientific explanations that rely more on common sense or faith. Let's take a look at how science approaches a question like the effectiveness of EMDR therapy.

EMDR therapy was developed by Francine Shapiro. Shapiro noticed that when she was experiencing a disturbing thought, her eyes were involuntarily moving rapidly. She noticed further that when she brought her eye movements under voluntary control while thinking a traumatic thought, anxiety was reduced (Shapiro, 1989). Based on her experience, Shapiro proposed EMDR as a new therapy for individuals suffering from posttraumatic stress disorder (PTSD). Shapiro speculated that traumatic events "upset the excitatory/inhibitory balance in the brain, causing a pathological change in the neural elements" (Shapiro, 1989, p. 216). Shapiro speculated that the eye movements used in EMDR coupled with traumatic thoughts restored the neural balance and reversed the brain pathology caused by the trauma. In short, eye movements were believed to be central to the power of EMDR to bring about rapid and dramatic reductions in PTSD symptoms.

Shapiro (1989) provided some evidence for the effectiveness of EMDR therapy in the form of a case study. Based on her research and her case studies, Shapiro concluded that EMDR was a unique, effective new therapy for PTSD. Other researchers did not agree. They pointed out that Shapiro's evidence (and evidence provided by others) was based on flawed research. Because EMDR was rapidly gaining popularity, it was necessary to test rigorously the claims made by advocates of EMDR that eye movements were essential to successful outcomes. Two researchers, George Renfrey and C. Richard Spates (1994), tested the claim that eye movements were a necessary component of EMDR therapy. Their study provides an excellent example of how scientists go about their business of uncovering true scientific explanations.

In their experiment Renfrey and Spates "deconstructed" the EMDR technique into its components. Patients with PTSD were randomly assigned to one of three conditions in the study. Some patients were assigned to a standard EMDR condition. Other patients were assigned to an automated EMDR condition in which eye movements were induced by having patients shift their eyes back and forth between two alternating lights. The remaining patients were assigned to a no eye movement group in which the patients fixated their eyes on a stationary light. In all three conditions all of the other essential elements of EMDR therapy (visualizing and thinking about a traumatic event) were maintained. Measures of heart rate and anxiety were obtained from patients. Renfrey and Spates found that there was no difference between the three treatment groups on any of the measures, leading them to conclude that "eye movements are not an essential component of the intervention" (Renfrey & Spates, 1994, p. 238). Subsequent research confirmed this conclusion (Davidson & Parker, 2001).

In contrast to nonscience and pseudoscience, a true science attempts to develop scientific explanations for behavior through the application of the scientific method and specific scientific research designs, just as Renfrey and Spates (1994) did when they tested the role of eye movements in EMDR therapy. Scientific explanations are the only ones accepted by scientists because they have a unique blend of characteristics that sets them apart from other explanations. Let's take a look at those characteristics next.

Scientific Explanations Are Empirical An explanation is *empirical* if it is based on the evidence of the senses. To qualify as scientific, an explanation must be based on objective and systematic observation, often carried out under carefully controlled conditions. The observable events and conditions referred to in the explanation must be capable of verification by others.

Scientific Explanations Are Rational An explanation is *rational* if it follows the rules of logic and is consistent with known facts. If the explanation makes assumptions that are known to be false, commits logical errors in drawing conclusions from its assumptions, or is inconsistent with established fact, then it does not qualify as scientific.

Scientific Explanations Are Testable A scientific explanation should either be verifiable through direct observation or lead to specific predictions about what should occur under conditions not yet observed. An explanation is *testable* if confidence in the explanation could be undermined by a failure to observe the predicted outcome. One should be able to imagine outcomes that would disprove the explanation.

Scientific Explanations Are Parsimonious Often more than one explanation is offered for an observed behavior. When this occurs, scientists prefer the **parsimonious explanation**, the one that explains behavior with the fewest number of assumptions.

Scientific Explanations Are General Scientists prefer explanations of broad explanatory power over those that "work" only within a limited set of circumstances.

Scientific Explanations Are Tentative Scientists may have confidence in their explanations, but they are nevertheless willing to entertain the possibility that an explanation is faulty. This attitude was strengthened in the past century by the realization that even Newton's conception of the universe, one of the most strongly supported views in scientific history, had to be replaced when new evidence showed that some of its predictions were wrong.

Scientific Explanations Are Rigorously Evaluated This characteristic derives from the other characteristics listed, but it is important enough to deserve its own place in our list. Scientific explanations are constantly evaluated for consistency with the evidence and with known principles, for parsimony, and for generality. Attempts are made to extend the scope of the explanation to cover broader areas and to include more factors. As plausible alternatives appear, these are pitted against the old explanations in a continual battle for the "survival of the fittest." In this way, even accepted explanations may be overthrown in favor of views that are more general, more parsimonious, or more consistent with observation.

QUESTIONS TO PONDER

1. How do science, protoscience, nonscience, and pseudoscience differ?
2. What are the defining characteristics of pseudoscience?
3. What are the main characteristics of scientific explanations? (Describe each.)

Commonsense Explanations Versus Scientific Explanations

During the course of everyday experience, we develop explanations of the events we see going on around us. Largely, these explanations are based on the limited information available from the observed event and what our previous experience has told us is true. These rather loose explanations can be classified as **commonsense explanations** because they are based on our own sense of what is true about the world around us. Of course, scientific explanations and commonsense explanations have something in common: They both start with an observation of events in the real world. However, the two types of explanations differ in the level of proof required to support the explanation. Commonsense explanations tend to be accepted at face value, whereas scientific explanations are subjected to rigorous research scrutiny.

Take the case of Tamir Rice, which occurred in 2015. Rice was a Black 12-year-old boy who was shot by a White police officer who believed that Rice had a real gun, when the gun was actually a realistic toy gun. Many in the Black community believed that the officer's behavior was racially motivated. The implication was that if Rice had been White, he would not have been shot by the police officer. That a police officer's racial prejudice might make him or her quicker to pull the trigger on a minority suspect might seem to be a viable explanation for what happened in the Tamir Rice case. Although this explanation may have some intuitive appeal, several factors disqualify it as a scientific explanation.

First, the "racism" explanation was not based on careful, systematic observation. Instead, it was based on what some *believe* to be true of the relationship between race and a police officer's behavior. Consequently, the explanation may have been derived from biased, incomplete, or limited evidence (if from any evidence at all). Second, it was not examined to determine its consistency with other available observations. Third, no effort was made to evaluate it against plausible alternative explanations. Fourth, no predictions were derived from the explanation and tested. Fifth, no attempt was made to determine how well the explanation accounted for similar behavior in a variety of other circumstances. Those who accepted this explanation did so simply because it appeared to make sense of the police officer's behavior and was consistent with their preexisting beliefs about how the police treat Black suspects. Because commonsense explanations are not rigorously evaluated, they are likely to be incomplete, inconsistent with other evidence, lacking in generality, and probably wrong. This is certainly the case with the "racism" explanation.

Although commonsense explanations may "feel right" and give us a sense that we understand a behavior, they may lack the power to apply across a variety of apparently similar situations. To see how commonsense explanations may fail to provide a truly general account of behavior, consider the following event.

On October 31, 2012, Halloween partygoers in the crowded Madrid Arena in Spain were having a great time. Suddenly, someone threw firecrackers into the arena. Partygoers believed that the firecrackers were gunshots and started to flee toward the one available exit. As the crowd surged forward in their panicked state, three people were crushed to death in the stampede. One witness who survived reported, "There were people screaming, crushed, as security guards tried to pull out those who were trapped." As a student of psychology, you may already be formulating explanations for why normally rational human beings would behave mindlessly in this situation. Clearly, lives would have been saved had the patrons of the Madrid Arena filed out in an orderly fashion. How would you explain the tragedy?

A logical and "obvious" answer is that the partygoers believed their lives to be in danger and wanted to leave the arena as quickly as possible. In this view, the panic inside the arena was motivated by a desire to survive.

Notice that the explanation at this point is probably adequate to explain the crowd behavior under the specific conditions inside the arena and perhaps to explain the same behavior under other life-threatening conditions. However, the explanation is probably too situation specific to serve as a general scientific explanation of irrational crowd behavior. It cannot explain, for example, the following incident.

On January 24, 2010, in Duisburg, Germany fans were lined up waiting to get into the Love Parade Festival. The festival is a very popular event where fans revel to the latest Techno music. The only entrance to the festival was through a tunnel leading to the parade grounds where the festival was taking place. As the parade grounds filled up, police attempted to halt the flow of additional people into the festival. The crowd in the tunnel began to grow and surge forward. In the end, 17 people were crushed to death. The tunnel was so densely packed that it took police some time to get to the victims.

Clearly, the explanation for irrational crowd behavior at the Madrid Arena cannot be applied to the Duisburg tragedy. People were not going to die if they failed to get into the arena. What seemed a reasonable explanation for irrational crowd behavior in the Madrid Arena case must be discarded.

You must look for common elements to explain such similar yet diverse events. In both situations, the available rewards were perceived to be limited. A powerful reward (avoiding pain and death) in the Madrid Arena undoubtedly was perceived as attainable only for a brief time. Similarly, in Duisburg the perceived reward (getting into a festival), although not essential for survival, was also available for a limited time only. In both cases, apparently irrational behavior resulted as large numbers of people individually attempted to maximize the probability of obtaining the reward.

The new tentative explanation for the irrational behavior now centers on the perceived availability of rewards rather than situation-specific variables. This new tentative explanation has been tested in research and has received some support.

As these examples illustrate, simple commonsense explanations may not apply beyond the specific situations that spawned them. The scientist interested in irrational crowd behavior would look for a more general concept (such as perceived availability of rewards) to explain observed behavior. That is not to say that simple, obvious explanations are always incorrect. However, when you are looking for an explanation that transcends situation-specific variables, you often must look beyond simple, commonsense explanations.

Belief-Based Explanations Versus Scientific Explanations

Explanations for behavior often arise not from common sense or scientific observation but from individuals or groups who (through indoctrination, upbringing, or personal need) have accepted on faith the truth of their beliefs. You may agree or disagree with those beliefs, but you should be aware that explanations offered by science and **belief-based explanations** are fundamentally different.

Explanations based on belief are accepted because they come from a trusted source or appear to be consistent with the larger framework of belief. No evidence is required. If evidence suggests that the explanation is incorrect, then the evidence is discarded or reinterpreted to make it appear consistent with the belief. For example, certain religions hold that Earth was created only a few thousand years ago. The discovery of fossilized remains of dinosaurs and other creatures (apparently millions of years old) challenged this belief. To explain the existence of these remains, people defending the belief suggest that fossils are actually natural rock formations that resemble bones or that the fossils are the remains of the victims of the Great Flood. Thus, rather than calling the belief into question, apparently contrary evidence is interpreted to appear consistent with the belief.

This willingness to apply a different *post hoc* (after-the-fact) explanation to reconcile each conflicting observation with a belief leads to an unparsimonious patchwork quilt of explanations that lacks generality, fails to produce testable predictions about future findings, and often requires that one assumes the common occurrence of highly unlikely events. Scientific explanations of the same phenomena, in contrast, logically organize the observed facts by means of a few parsimonious assumptions and lead to testable predictions.

Nowhere is the contrast between these two approaches more striking than in the debate between evolutionary biologists and the so-called creation scientists, whose explanation for fossils was previously mentioned. To take one example, consider the recent discoveries based on gene sequencing, which reveal the degree of genetic similarity among various species. These observations and some simple assumptions about the rate of mutation in the genetic material allowed biologists to develop "family trees" indicating how long ago the various species separated from one another. The trees drawn up from the gene-sequencing data agree amazingly well with and to a large degree were predicted by the trees assembled from the fossil record. In contrast, because creationists assume that all animals alive today have always had their current form and that fossils represent the remains of animals killed in the Great Flood, their view could not have predicted relationships found in the genetic material. Instead, they must invent yet another *post hoc* explanation to make these new findings appear consistent with their beliefs.

In addition to the differences described thus far, scientific and belief-based explanations also differ in tentativeness. Whereas explanations based on belief are simply *assumed* to be true, scientific explanations are accepted because they are consistent with existing objective evidence and have survived rigorous testing against plausible alternatives. Scientists accept the possibility that better explanations may turn up or that new tests may show that the current explanation is inadequate.

Scientific explanations also differ from belief-based explanations in the subject areas for which explanations are offered. Whereas explanations based on belief may seek to answer virtually any question, scientific explanations are limited to addressing those questions that can be answered by means of objective observations. For example, what happens to a person after death and why suffering exists in the world are explained by religion, but such questions remain outside the realm of scientific explanation. No objective tests or observations can be performed to answer these questions within the confines of the scientific method. Science offers no explanation for such questions, and you must rely on faith or belief for answers. However, for questions that can be settled on the basis of objective observation, scientific explanations generally have provided more satisfactory and useful accounts of behavior than those provided by a priori beliefs.

QUESTIONS TO PONDER

1. How do scientific and commonsense explanations differ?
2. How do belief-based and scientific explanations differ?
3. What kinds of questions do scientists refrain from investigating? Why do scientists refrain from studying these issues?

WHEN SCIENTIFIC EXPLANATIONS FAIL

Scientific explanation is preferable to other kinds of explanation when scientific methods can be applied. Using a scientific approach maximizes the chances of discovering the best explanation for an observed behavioral phenomenon. Despite the application of the most rigorous scientific methods, instances do occur in which the explanation offered by a scientist is not valid. Scientific explanations are sometimes flawed. Understanding some of the pitfalls inherent to developing scientific explanations will help you avoid arriving at flawed or incorrect explanations for behavior.

Failures Due to Faulty Inference

Explanations may fail because developing them involves an inference process. We make observations and then infer the causes for the observed behavior. This inference process always involves the danger of incorrectly inferring the underlying mechanisms that control behavior.

The problem of faulty inference is illustrated in a satirical book by David Macaulay (1979) called *Motel of the Mysteries*. In this book, a scientist (Howard Carson) uncovers the remnants of our civilization 5,000 years from now. Carson unearths a motel and begins the task of explaining what our civilization was like, based on the artifacts found in the motel.

Among the items unearthed were various bathroom plumbing devices: a plunger, a showerhead, and a spout. These items were assumed by Carson to be musical instruments. The archaeologist describes the items as follows:

> The two trumpets [the showerhead and spout] . . . were found attached to the wall of the inner chamber at the end of the sarcophagus. They were both coated with a silver substance similar to that used on the ornamental pieces of the metal animals. Music was played by forcing water from the sacred spring through the

> trumpets under great pressure. Pitch was controlled by a large silver handle marked HC. . . . The [other] instrument [the plunger] is probably of the percussion family, but as yet the method of playing it remains a mystery. It is, however, beautifully crafted of wood and rubber. (Macaulay, 1979, p. 68)

By hypothesizing that various plumbing devices served as ceremonial musical instruments, Macaulay's archaeologist has reached a number of inaccurate conclusions. Although the *Motel of the Mysteries* example is pure fiction, real-life examples of inference gone wrong abound in science, and psychology is no exception. R. E. Fancher (1985) described the following example in his book *The Intelligence Men: Makers of the IQ Controversy*. During World War I, the U.S. Army administered group intelligence tests under the direction of Robert Yerkes. More than 1.75 million men had taken either the Alpha or Beta version of the test by the end of the war and provided an excellent statistical sample from which conclusions could be drawn about the abilities of U.S. men of that era.

The results were shocking. Analysis of the data revealed that the average army recruit had a mental age of 13 years—3 years below the "average adult" mental age of 16 and only 1 year above the upper limit for moronity. Fancher described Yerkes's interpretation as follows:

> Rather than interpreting his results to mean that there was something wrong with the standard, or that the army scores had been artificially depressed by . . . the failure to re-test most low Alpha scorers on Beta, as was supposed to have been the case, Yerkes asserted that the "native intelligence" of the average recruit was shockingly low. The tests, he said, were "originally intended, and now definitely known, to measure native intellectual ability. They are to some extent influenced by educational acquirement, but in the main the soldier's inborn intelligence and not the accidents of environment determined his mental rating or grade." Accordingly, a very substantial proportion of the soldiers in the U.S. Army were actually morons. (1985, p. 127)

In fact, Yerkes's assertions about the tests were not in any sense established, and indeed the data provided evidence against Yerkes's conclusion. For example, poorly educated recruits from rural areas scored lower than their better-educated city cousins. Yerkes's tests had failed to consider the differences in educational opportunities among recruits. As a result, Yerkes and his followers inappropriately concluded that the average intellectual ability of Americans was deteriorating.

In the Yerkes example, faulty conclusions were drawn because the conclusions were based on unfounded assumptions concerning the ability of the tests to unambiguously measure intelligence. The researchers failed to consider possible *alternative explanations* for observed effects. Although the intelligence of U.S. Army recruits may in fact have been distressingly low, an alternative explanation centering on environmental factors such as educational level would have been equally plausible. These two rival explanations (real decline in intelligence versus lack of educational experience) should have been subjected to the proper tests to determine which was more plausible. Later, this book discusses how developing, testing, and eliminating such rival hypotheses are crucial elements of the scientific method.

Pseudoexplanations

Failing to consider alternative explanations is not the only danger waiting to befall the unwary scientist. In formulating valid scientific explanations for behavioral events, it is important to avoid the trap of **pseudoexplanation**. In seeking to provide explanations for behavior, psychologists sometimes offer positions, theories, and explanations that do nothing more than provide an alternative label for the behavioral event. One notorious example was the attempt to explain aggression with the concept of an instinct. According to this position, people (and animals) behave aggressively because of an aggressive instinct. Although this explanation may have intuitive appeal, it does not serve as a valid scientific explanation.

Figure 1-1 illustrates the problem with such an explanation. Notice that the observed behavior (aggression) is used to prove the existence of the aggressive instinct. The concept of instinct is then used to explain the aggressive behavior.

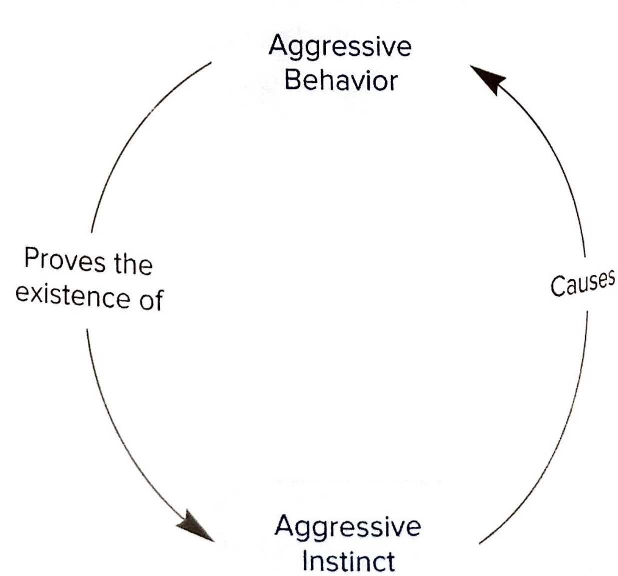
This form of reasoning is called a **circular explanation**, or **tautology**. It does not provide a true explanation but rather merely provides another label (instinct) for a class of observed behavior (aggression). Animals are aggressive because they have aggressive instincts. How do we know they have aggressive instincts? Because they are aggressive! Thus, all we are saying is that animals are aggressive because of a tendency to behave aggressively. Obviously, this is not an explanation.

You might expect only novice behavioral scientists to be prone to using pseudoexplanations. However, even professional behavioral scientists have proposed "explanations" for behavioral phenomena that are really pseudoexplanations. In a 1970 article, Martin Seligman proposed a continuum of preparedness to help explain why an animal can learn some associations easily (such as between taste and illness) and other associations only with great difficulty (such as between taste and electric shock).

According to Seligman's analysis, the animal may be biologically prepared to learn some associations (those learned quickly) and contraprepared to learn others (those learned slowly, if at all). Thus, some animals may have difficulty acquiring an association between taste and shock because they are contraprepared by evolution to associate the two.

As with the use of instinct to explain aggression, the continuum-of-preparedness notion seems intuitively correct. Indeed, it does serve as a potentially valid explanation

FIGURE 1-1 A circular explanation. The observed behavior is "explained" by a concept, but the behavior itself is used as proof of the existence of the explanatory concept.



for the observed differences in learning rates. But it does not qualify as a true explanation as it is stated. Refer to Figure 1-1 and substitute "quickly or slowly acquired association" for "aggressive behavior" and "continuum of preparedness" for "aggressive instinct." As presently stated, the continuum-of-preparedness explanation is circular: Animals learn a particular association with difficulty because they are contraprepared to learn it. How do you know they are contraprepared? You know because they have difficulty learning.

How can you avoid falling into the trap of proposing and accepting pseudo-explanations? When evaluating a proposed explanation, ask yourself whether or not the researcher has provided *independent measures* of the behavior of interest (such as difficulty learning an association) *and* the proposed explanatory concept (such as the continuum of preparedness). For example, if you could find an independent measure of preparedness that does *not* involve the animal's ability to form an association, then the explanation in terms of preparedness would qualify as a true explanation. If you can determine the animal's preparedness only by observing its ability to form a particular association, the proposed explanation is circular. Rather than explaining the differing rates of learning, the statement actually serves only to define the types of preparedness.

Developing independent measures for the explanatory concept and the behavior to be explained may not be easy. For example, in the continuum-of-preparedness case, it may take some creative thought to develop a measure of preparedness that is independent of the observed behavior. The same is true for the concept of an instinct.

As these examples have illustrated, even scientific explanations may fail. However, you should not conclude that such explanations are no better than those derived from other sources. Living, behaving organisms are complex systems whose observable workings provide only clues to their inner processes. Given the available evidence, you make your best guess. It should not be surprising that these guesses are often wrong. As these conjectures are evaluated against new evidence, even the failures serve to rule out plausible alternatives and to prepare the way for better guesses. As a result, science has a strong tendency to converge on valid explanations as research progresses. Such progress in understanding is a hallmark of the scientific method.

The Emergence of New, Conflicting Information

Previously, we made the points that humans have a strong need to explain what they experience and that scientific explanations are tentative. Sometimes science provides us with a scientific explanation, only to have it called into question when new scientific evidence emerges. The new information requires us to modify what we previously believed to be true. Unfortunately, humans can be remarkably resistant to modifying existing beliefs in the face of new evidence. Social psychologists call this phenomenon *belief perseverance*.

A good example of belief perseverance was the "science" of cereology, which was proposed to account for crop circles that appeared most notably in England. In an attempt to explain the crop circles, a whole science developed involving scientists taking various measurements to help explain where the mysterious circles came from. Scientists published their results in journals and presented their findings at for the observed differences in learning rates. But it does not qualify as a true explanation as it is stated. Refer to Figure 1-1 and substitute "quickly or slowly acquired association" for "aggressive behavior" and "continuum of preparedness" for "aggressive instinct." As presently stated, the continuum-of-preparedness explanation is circular: Animals learn a particular association with difficulty because they are contraprepared to learn it. How do you know they are contraprepared? You know because they have difficulty learning.

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The Method of Authority

After reading about the Madrid Arena tragedy, you might conduct an Internet search or call your former social psychology professor in search of information to help explain the irrational behavior inside the arena. When you use expert sources (whether books or people), you are using the **method of authority**. Using the method of authority involves consulting some source that you consider authoritative on the issue in question (e.g., consulting books, television, religious leaders, scientists, or the Internet).

Although useful in the early stages of acquiring knowledge, the method of authority does not always provide valid answers to questions about behavior for at least two reasons. First, the source that you consult may not be truly authoritative. Some persons are more than willing to give you their "expert" opinions on any topic, no matter how little they actually know about it (writers are no exception). Internet sources are particularly suspect. Anyone can post anything they want on the Internet. Consequently, you cannot be certain that information you obtain there is valid. (We cover this issue in more detail in Chapter 3.) Second, sources often are biased by a particular point of view. A sociologist may offer a different explanation for the Madrid Arena tragedy from the one offered by a behaviorally oriented psychologist. For these reasons, the method of authority by itself is not adequate for producing reliable explanations.

Although the method of authority is not the final word in the search for explanations of behavior, the method does play an important role in the acquisition of scientific knowledge. Information that you obtain from authorities on a topic can familiarize you with the problem, the available evidence, and the proposed explanations. With this information, you could generate new ideas about causes of behavior. However, these ideas must then be subjected to rigorous scientific scrutiny rather than being accepted at face value.

The Rational Method

René Descartes proposed in the 17th century that valid conclusions about the universe could be drawn through the use of pure reason, a doctrine called *rationalism*. This proposal was quite revolutionary at the time because most scholars of the day relied heavily on the method of authority to answer questions. Descartes' method began with skepticism, a willingness to doubt the truth of every belief. Descartes noted, as an example, that it was even possible to doubt the existence of the universe. What you perceive, he reasoned, could be an illusion. Could you prove otherwise?

After establishing doubt, Descartes moved to the next stage of his method: the search for "self-evident truths," statements that *must* be true because to assume otherwise would contradict logic. Descartes reasoned that if the universe around him did not really exist, then perhaps he himself also did not exist. It was immediately obvious to Descartes that this idea contradicted logic—it was self-evidently true that if he did not exist, he certainly could not be thinking about the question of his own existence. And it was just as self-evidently true that he was indeed thinking.

These two self-evident truths can be used as assumptions from which deductive logic will yield a firm conclusion:

Assumption 1: Something that thinks must exist.

Assumption 2: I am thinking.

Conclusion: I exist.

Using only his powers of reasoning, Descartes had identified two statements whose truth logically cannot be doubted, and from them he was able to deduce a conclusion that is equally bulletproof. It is bulletproof because, if the assumptions are true and you make no logical errors, deduction guarantees the truth of the conclusion. By the way, this particular example of the use of his method was immortalized by Descartes in the declaration *"Cogito, ergo sum"* (Latin for "I think, therefore I am"). If you've heard that phrase before and wondered what it meant, now you know.

Descartes' method came to be called the **rational method** because it depends on logical reasoning rather than on authority or the evidence of one's senses. Although the method satisfied Descartes, we must approach "knowledge" acquired in this way with caution. The power of the rational method lies in logically deduced conclusions from self-evident truths. Unfortunately, precious few self-evident truths can serve as assumptions in a logical system. If one (or both) of the assumptions used in the deduction process is incorrect, the logically deduced conclusion will be invalid.

Because of its shortcomings, the rational method is not used to develop scientific explanations. However, it still plays an important role in science. The tentative ideas that we form about the relationship between variables are often deduced from earlier assumptions. For example, having learned that fleeing from a fire or trying to get into a crowded arena causes irrational behavior, we may deduce that "perceived availability of reinforcers" (escaping death or getting a front-row seat) is responsible for such behavior. Rather than accepting such a deduction as correct, however, the scientist puts the deduction to empirical test.

The Scientific Method

Braithwaite (1953) proposed that the function of a science is to "establish general laws covering the behavior of the empirical events with which the science in question is concerned" (p. 1). According to Braithwaite, a science should allow us to fuse together information concerning separately occurring events and to make reliable predictions about future, unknown events. One goal of psychology is to establish general laws of behavior that help explain and predict behavioral events that occur in a variety of situations.

Although explanations for behavior and general laws cannot be adequately formulated by relying solely on authoritative sources and using deductive reasoning, these methods (when combined with other features) form the basis for the most powerful approach to knowledge yet developed: the **scientific method**. This method comprises a series of four cyclical steps that you can repeatedly execute as you pursue the solution to a scientific problem (Yaremko et al., 1982, p. 212). These steps are (1) observing a phenomenon, (2) formulating tentative explanations or statements of cause and effect, (3) further observing or experimenting (or both) to rule out alternative explanations, and (4) refining and retesting the explanations.

Observing a Phenomenon The starting point for using the scientific method is to observe the behavior of interest. This first step is essentially what Cialdini (1994) called "scouting" in which some behavior or event catches your attention. These preliminary observations of behavior and of potential causes for that behavior can take a variety of forms. In the case of the effects of cell phone distraction while walking, your initial musings about Christopher Cepeda's accident may have led you to think more carefully about the role of distraction on the ability to perform a complex task. Your curiosity might have been further piqued when divided attention was discussed in your cognitive psychology class or when you read about another case where cell phone distraction was a suspected cause of an accident. Or you might even have known someone who was nearly killed in an accident while talking on his cell phone and attempting to cross a street at the same time. In any of these cases, your curiosity might be energized so that you begin to formulate hypotheses about what factors affect the behavior you have observed.

Through the process of observation, you identify variables that appear to have an important influence on behavior. A **variable** is any characteristic or quantity that can take on two or more values. For example, whether a participant is talking on a cell phone or not while walking is a variable. Remember that in order for something to be considered a variable it must be capable of taking on *at least* two values (e.g., talking on a cell phone or not talking on a cell phone). A characteristic or quantity that takes on only one value is known as a *constant*.

Formulating Tentative Explanations After identifying an interesting phenomenon to study, your next step is to develop one or more tentative explanations that seem consistent with your observations. In science these tentative explanations often include a statement of the relationship between two or more variables. That is, you tentatively state the nature of the relationship between variables that you expect to uncover with your research. The tentative statement that you offer concerning the relationship between your variables of interest is called a *hypothesis*. It is important that any hypothesis you develop be testable with empirical research.

As an example of formulating a hypothesis, consider the issue of the relationship between talking on a cell phone and walking. After your preliminary observations, you might formulate the following hypothesis: A person is more likely to enter a dangerous situation when talking on a cell phone than when not talking on a cell phone.

Notice that the hypothesis links two variables (talking or not talking on a cell phone and entering dangerous situations) by a statement indicating the expected relationship between them. In this case, the relationship expected is that talking on a cell phone will increase errors on a simulated walking task. Research hypotheses often take the form of a statement of how changes in the value of one variable (talking or not talking on a cell phone) will affect the value of the other variable (number of dangerous situations entered).

Further Observing and Experimenting When Cialdini (1994) talked about "trapping" effects, he was referring to the process of designing empirical research studies to isolate the relationship between the variables chosen for study. Up to the point of developing a hypothesis, the scientific method does not differ markedly from other methods of acquiring knowledge. At this point, all you have done is to identify a problem to study and develop a hypothesis based on some initial observation. The scientific method, however, does not stop here. The third step in the scientific method marks the point at which the scientific method differs from other methods of inquiry. Unlike the other methods of inquiry, the scientific me[...] carried out to test the validity of any hypotheses that you develop. In other words, "a-trapping we shall go."

What exactly is meant by "making further observations"? The answer to this question is what the scientific method is all about. After formulating your hypothesis, you design a research study to test the relationship that you proposed. This study can take a variety of forms. It could be a *correlational study* in which you measure two or more variables and look for a relationship between them (see Chapter 4), a *quasi-experimental study* in which you take advantage of some naturally occurring event or preexisting conditions, or an *experiment* in which you systematically manipulate a variable and look for changes in the value of another that occur as a result (see Chapters 10–12).

In this case, you decide to design an experiment in which you systematically manipulate whether a person talks on a cell phone and observe the number of errors made on a simulated walking task.

Refining and Retesting Explanations The final step in the scientific method is the process of refinement and retesting. As an example of this process, imagine that you found that individuals are more likely to bump into things while texting on a cell phone. Having obtained this result, you would probably want to explore the phenomenon further: Is texting more distracting than doing something else (e.g., conversing) while walking? A refined research hypothesis might take the following form: A pedestrian will be more likely to enter a dangerous situation while texting than when talking with others in a live conversation.

This process of generating new, more specific hypotheses in the light of previous results illustrates the *refinement process*. Often, confirming a hypothesis with a research study leads to other hypotheses that expand on the relationships discovered, explore the limits of the phenomenon under study, or examine the causes for the relationship observed.

As you become more familiar with the process of conducting research, you will find that not all research studies produce affirmative results. That is, sometimes your research does not confirm your hypothesis. What do you do then? In some cases, you might completely discard your original hypothesis. In other cases, however, you might revise and retest your hypothesis. In the latter instance, you are using a strategy known as *retesting*. Keep in mind that any revised or refined hypothesis must be tested as rigorously as was the original hypothesis.

The scientific method requires a great deal of time making careful observations. Sometimes your observations don't confirm your hypothesis. Is the scientific method worth all the extra effort? In fact, the ability to discover that a relationship does *not* exist makes the scientific method the powerful tool that it is. By repeatedly checking and rechecking hypotheses in the ruthless arena of empirical testing, the scientist learns which ideas are worthy and which belong on the trash heap. No other method incorporates such a powerful check on the validity of its conclusions.

Finally, it is worth noting that the scientific method should not be construed as a rigid series of stages that *must* be followed, and in the same order, for all research situations (Gibbs & Lawson, 1992). As you become more familiar with the research process and your own research, you will undoubtedly find that the scientific method is a highly flexible template that you will apply to address and answer a wide range of other methods of inquiry, the scientific ... you develop. In other words, carried out to test the validity of any hypotheses that ... "a-trapping we shall go."

What exactly is meant by "making further observations"? The answer to this question is what the scientific method is all about. After formulating your hypothesis, you design a research study to test the relationship that you proposed. This study can take a variety of forms. It could be a *correlational study* in which you measure two or more variables and look for a relationship between them (see Chapter 4), a *quasi-experimental study* in which you take advantage of some naturally occurring event or preexisting conditions, or an *experiment* in which you systematically manipulate a variable and look for changes in the value of another that occur as a result (see Chapters 10–12).

In this case, you decide to design an experiment in which you systematically manipulate whether a person talks on a cell phone and observe the number of errors made on a simulated walking task.

Refining and Retesting Explanations The final step in the scientific method is the process of refinement and retesting. As an example of this process, imagine that you found that individuals are more likely to bump into things while texting on a cell phone. Having obtained this result, you would probably want to explore the phenomenon further: Is texting more distracting than doing something else (e.g., conversing) while walking? A refined research hypothesis might take the following form: A pedestrian will be more likely to enter a dangerous situation while texting than when talking with others in a live conversation.

This process of generating new, more specific hypotheses in the light of previous results illustrates the *refinement process.* Often, confirming a hypothesis with a research study leads to other hypotheses that expand on the relationships discovered, explore the limits of the phenomenon under study, or examine the causes for the relationship observed.

As you become more familiar with the process of conducting research, you will find that not all research studies produce affirmative results. That is, sometimes your research does not confirm your hypothesis. What do you do then? In some cases, you might completely discard your original hypothesis. In other cases, however, you might revise and retest your hypothesis. In the latter instance, you are using a strategy known as *retesting.* Keep in mind that any revised or refined hypothesis must be tested as rigorously as was the original hypothesis.

The scientific method requires a great deal of time making careful observations. Sometimes your observations don't confirm your hypothesis. Is the scientific method worth all the extra effort? In fact, the ability to discover that a relationship does *not* exist makes the scientific method the powerful tool that it is. By repeatedly checking and rechecking hypotheses in the ruthless arena of empirical testing, the scientist learns which ideas are worthy and which belong on the trash heap. No other method incorporates such a powerful check on the validity of its conclusions.

Finally, it is worth noting that the scientific method should not be construed as a rigid series of stages that *must* be followed, and in the same order, for all research situations (Gibbs & Lawson, 1992). As you become more familiar with the research process and your own research, you will undoubtedly find that the scientific method is a highly flexible template that you will apply to address and answer a wide range of research questions. More than anything, the scientific method will become a way of seeing the world and approaching research questions. It will allow you to explore behavior from a scientific perspective and work toward developing scientific explanations for the behaviors you observe.

The Scientific Method at Work: Using a Cell Phone While Walking

Throughout this chapter, we've used the issue of the safety of cell phone use while walking to illustrate how you might go about developing, testing, and refining a research hypothesis. As you may have suspected, the question has actually been the subject of scientific research, and we thought it might be helpful for you to see how an actual research study on this topic was carried out. The study that we chose for our example was conducted by Katherine Byington and David Schwebel (2013).

Byington and Schwebel (2013) exposed their participants to a virtual environment (VE) comprising a 180-degree view of busy street and accompanying sounds of birds and traffic. Participants were asked to step off a "curb" when they felt it safe to cross the street, and as they did so, an avatar resembling themselves began to cross the street at a speed matched to participants' natural walking speed. If a participant stepped off the curb at the wrong time, the avatar might be hit or nearly hit by a passing vehicle.

Participants were exposed repeatedly to two conditions. In one condition they attempted to cross the virtual street without distraction. In the other, they attempted to cross the street while answering e-mailed questions that required them to do some Internet searching to find the answers. Byington and Schwebel (2013) summarized their results as follows:

> While distracted in the VE, participants looked to the left and right less before crossing, spent a greater percentage of time looking away from the road, took longer to initiate crossing when a safe gap was available, and were hit or almost hit by oncoming vehicles more often. They also waited longer to cross and missed more safe opportunities to cross.

The Byington and Schwebel study thus offers scientific support for our previous speculation that texting or otherwise interacting with the Internet on a cell phone increases the dangers inherent in crossing a busy street.

QUESTIONS TO PONDER

1. What are the defining characteristics and weaknesses of the method of authority and the rational method?
2. How are the method of authority and rational method used in science?
3. What are the steps involved in the scientific method?
4. Why is the scientific method preferred in science?

The Steps of the Research Process

Scientists in the field of psychology adhere to the scientific method as the principal method for acquiring information about behavior. This is true whether the psychologist is a *clinical psychologist* evaluating the effectiveness of a new therapy technique or an *experimental psychologist* investigating the variables that affect memory. Of course, researchers in psychology adopt a wide variety of techniques in their quest for scientific knowledge.

From the inception of a research idea to the final report of results, the research process has several crucial steps. These steps are outlined in Figure 1-2. At each step, you must make one or more important decision that will influence the direction of your research. Let's explore each of these steps and some of the decisions you must make.

Developing a Research Idea and Hypothesis The first step in the research process is to identify an issue that you want to study. There are many sources of research ideas (e.g., observing everyday behavior or reading scientific journals). Once you have identified a behavior to study, you must then state a research question in terms that will allow others to test it empirically. Many students of research have trouble at this point. Students seem to have little trouble identifying interesting, broadly defined behaviors to study (e.g., "I want to study memory"), but they have trouble isolating crucial variables that need to be explored.

Applying the scientific method requires you to state clearly the relationships that you expect to emerge in a research study. In other words, you must be able to formulate a precise, testable hypothesis. As noted in Figure 1-2, hypothesis development involves **deductive reasoning**, which involves deriving a specific hypothesis (in this case) from general ideas. For example, during your literature review, you may have come across information on why walking while texting on a cell phone leads to decreased performance. Using the information you found, you might deduce that one variable (the complexity of a texting task) causes changes in a second (the ability to move through an environment). The specific statement you develop connecting these two variables is your hypothesis.

Choosing a Research Design Once you have narrowed your research question and developed a testable hypothesis, you must next decide on a research design to test it. As discussed in later chapters, a variety of options is available to you. Other important decisions at this point include where to conduct your study (in the laboratory or in the field) and how you are going to measure the behavior of interest.

Choosing Subjects Your next decision concerns your research subjects. There are two options available to you: human participants or animal subjects. Whichever you choose, you must decide how to obtain your subjects and how they will be handled in your study. You also must be concerned with treating your subjects in an ethical manner.

Deciding on What to Observe and Appropriate Measures Your next step is to decide the behavior you want to observe. This will be determined by the topic or issue that you have chosen to study. For example, if you were interested in the issue of the effects of distraction on walking ability you need a measure of walking ability. After choosing what to observe, you must next decide on the most appropriate way to

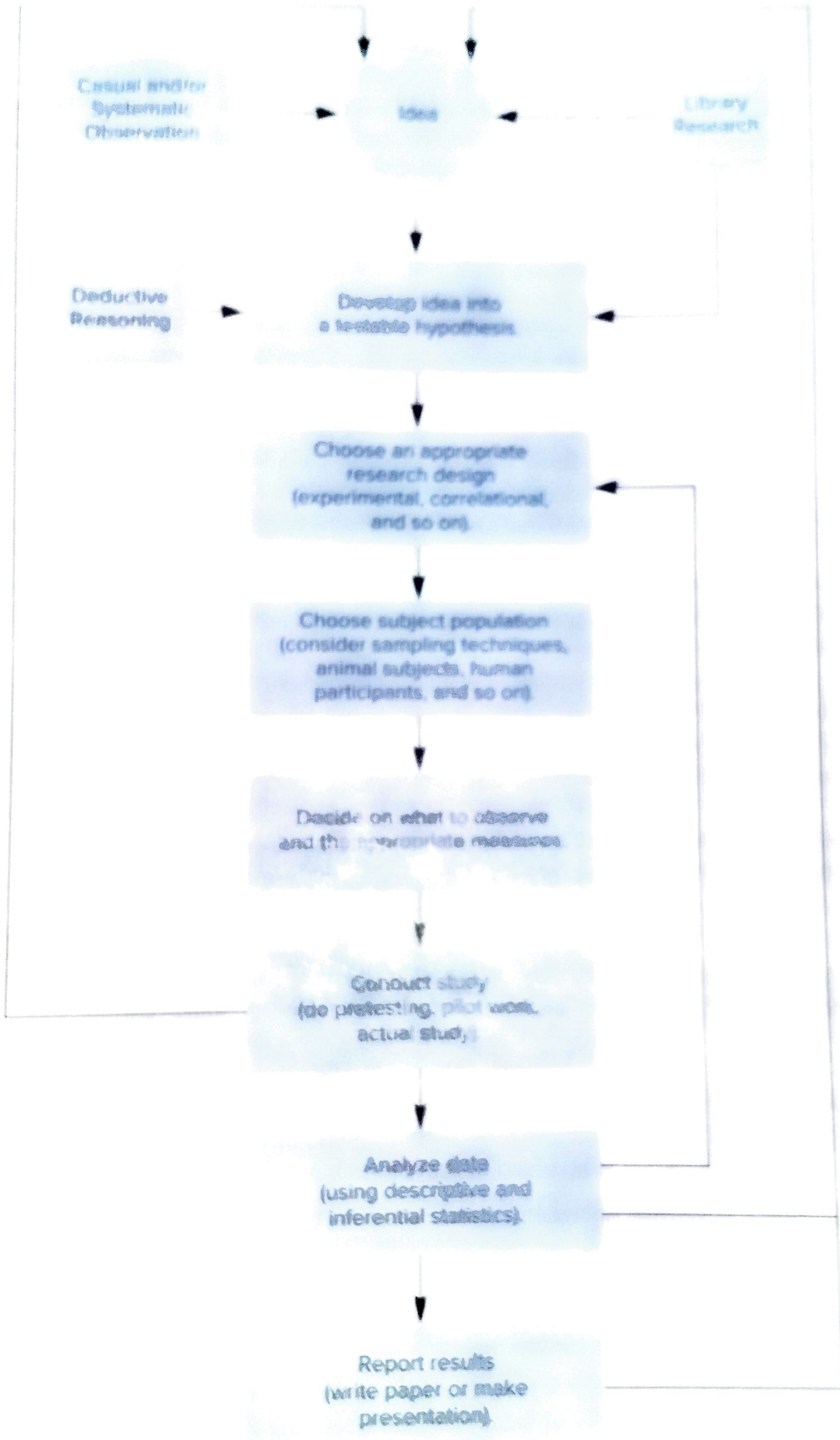

FIGURE 1-2 The research process. Arrows show the sequence of steps, along with feedback pathways.

measure the behavior of interest. For example, should you use a measure used in previous research or develop a new one?

With the preliminary decisions out of the way, you must consider a host of practical issues (equipment needs, preparation of materials, etc.). You might find it necessary to conduct a miniature version of your study, called a **pilot study**, to be sure your chosen procedures and materials work the way that you think they will.

Conducting Your Study Now you actually have your participants take part in your study. You observe and measure their behavior. Data are formally recorded for later analysis.

Analyzing Your Results After you have collected your data, you must summarize and analyze them. The analysis process involves a number of decisions. You can analyze your data in several ways, and some types of data are better analyzed with one method than with another. In most cases, you will probably calculate some descriptive statistics that provide a "nutshell" description of your data (such as averages and standard deviations) and inferential statistics that assess the reliability of your data (such as a *t test*).

Reporting Your Results After analyzing your data, you are nearing the final steps in the research process. You are now ready to prepare a report of your research. If your results were reliable and sufficiently important, you may want to publish them. Consequently, you would prepare a formal paper, usually in American Psychological Association (APA) style, and submit it to a journal for review. You also might decide to present your paper at a scientific meeting, in which case you prepare a brief abstract of your research for review.

Starting the Whole Process Over Again Your final report of your research is usually not the final step in your research. You may have achieved closure on (finished and analyzed) one research project. However, the results from your first study may raise more questions. These questions often serve as the seeds for a new study. In fact, you may want to replicate an interesting finding within the context of a new study. This possibility is represented in Figure 1-2 by the arrow connecting "Report results" with "Idea."

QUESTIONS TO PONDER

1. What are the steps involved in the research process?
2. What important decisions must be made at each step of the research process?

SUMMARY

Although we are constantly trying to explain the behavior that we see around us, commonsense explanations of behavior often are too simplistic, situation specific, and frequently based on hearsay, conjecture, anecdote, or other unreliable sources. Scientific explanations are based on carefully made observations of behavior, rigorously tested against alternative explanations, and developed to provide the most general account that is applicable over a variety of situations. For these reasons, scientific explanations tend to be more valid and general than those provided by common sense.

The goal of the science of psychology is to build an organized body of knowledge about its subject matter and to develop explanations for phenomena within its domain. It is important to distinguish between a true science, protoscience, nonscience, and pseudoscience because the quality of the information obtained depends on how it is acquired. The principal method used in a true science to build an organized body of knowledge and develop scientific explanations is research. Research involves three steps: identifying a phenomenon to study, discovering information about that phenomenon, and developing explanations for the phenomenon. A useful analogy is to think of science as a hunting trip. First, you scout where you are going to hunt for prey (analogous to identifying a phenomenon to study). Second, you go hunting to trap your prey (analogous to discovering information and developing explanations).

Explanations for behavior also are provided by beliefs. Explanations provided by belief differ from scientific explanations in that they are considered absolutely true, whereas scientific explanations are always considered tentative. Consequently, when evidence conflicts with an explanation based on belief, the evidence is questioned. When evidence conflicts with a scientific explanation, the explanation is questioned. Although beliefs can provide answers to virtually any question, the scientific method can address only those questions that can be answered through observation.

Even explanations that sound scientific may fail because relationships are often inferred from observable events. The danger always exists that inferences are incorrect, despite being based on empirical data. An explanation also may fail if you do not use independent measures of the explanatory concept and the behavior to be explained. In such cases, you have a pseudoexplanation, which is only a new label for behavior. Finally, an explanation may fail because new, reliable evidence emerges that contradicts the explanation.

There are many ways to acquire knowledge about behavior. With the method of authority, you acquire information from sources that you perceive to be expert on your topic of interest and use the information to develop an explanation for behavior. With the rational method, you deduce explanations from other sources of information. Although the method of authority and the rational method play important roles in the early stages of science, they are not acceptable methods for acquiring scientific knowledge. The scientific method is the only method accepted for the acquisition of scientific knowledge.

The four major steps of the scientific method are (1) observation of a phenomenon, (2) formation of tentative explanations or statements of cause and effect, (3) further observation or experimentation to rule out alternative explanations (or both), and (4) retesting and refinement of the explanations. The scientific method is also an attitude or a way of viewing the world. The scientist frames problems in terms of the scientific method.

The scientific method is translated into action by the research process. When performing research, you first choose a technique. Regardless of the technique chosen, research must follow the guidelines of the scientific method. The science of psychology is highly complex and diverse, and the goals of research vary from individual to individual. Some researchers, who are mainly interested in solving real-world problems, conduct applied research. Other scientists, mainly those interested in evaluating theoretical problems, conduct basic research. Even though basic and applied research are different to some extent, considerable overlap does exist. Some basic research problems have real-world applications, and some applied problems have some basic research undertones.

The research process involves a sequence of steps. At each step, important decisions affect the course of research and how you analyze and interpret data. The steps in the research process are (1) develop a research idea into a testable hypothesis, (2) choose a research design, (3) choose a subject or participant population, (4) decide on what to observe and appropriate measures, (5) obtain subjects or participants for the study and conduct the study, (6) analyze results, and (7) report results. Often the results of research raise a host of new research ideas, which starts the whole research process over again.

KEY TERMS

science
scientist
basic research
applied research
confirmation bias
protoscience
pseudoscience
scientific explanation
parsimonious explanation
commonsense explanations
belief-based explanation
pseudoexplanation
circular explanation or tautology
method of authority
rational method
scientific method
variable
deductive reasoning
pilot study