Scientific Thinking in Psychology

1

PREVIEW & CHAPTER OBJECTIVES

Welcome to what might be the most important course you will take as a psychology student. This opening chapter begins by trying to convince you that a research methods course is essential to your education, whether or not you have a future as a research psychologist. The chapter then proceeds with an introduction to the ways in which we come to know things in our world. Some of what we know comes from our reliance on authority figures, other knowledge results from our ability to reason, and we have often heard that experience is the best teacher. All these avenues to knowledge have merit, but each is flawed. Research psychologists rely on scientific thinking as a way to discover truth, and this opening chapter carefully examines the general nature of science, describes the scientific way of thinking, and contrasts it with pseudoscientific thinking. Distinguishing science from pseudoscience is especially important for psychology, because some things that are promoted as "psychological truth" (e.g., the ability to assess personality by examining someone's handwriting) are actually examples of pseudoscience rather than true science. The chapter closes by discussing the goals for a scientific psychology, and brief introductions to the work of two of experimental psychology's legendary stars, Eleanor Gibson and B. F. Skinner. They both showed the passion and commitment that psychological scientists have for their work. When you finish this chapter, you should be able to:

- Defend the need for a research methods course for psychology students.
- Explain how the overall purpose of a methods course differs from other psychology courses.
- Identify and evaluate nonscientific ways of knowing about things in the world—authority, reasoning, and experience.
- Describe the attributes of science as a way of knowing, which assumes determinism and discoverability; makes systematic observations; produces public, data-driven, but tentative knowledge; asks answerable questions; and develops theories that attempt to explain psychological phenomena.
- Distinguish science from pseudoscience and recognize the attributes of pseudoscientific thinking.
- Describe the main goals of research in psychology and relate them to various research strategies to be encountered later in the book.

In the preface to his weighty two-volume *Principles of Physiological Psychology*, published in 1874, the German physiologist Wilhelm Wundt boldly and unambiguously declared that his text represented "an attempt to mark out a new domain of *science*" (Wundt, 1874/1904; italics added). Shortly after publishing the book, Wundt established his now famous psychology laboratory at Leipzig, Germany, attracting students from all over Europe as well as from the United States. American universities soon established their own laboratories, about 20 of them by 1892 (Sokal, 1992). In that same year the American Psychological Association (APA) was founded, and before long it ratified a constitution identifying its purpose as "the advancement of Psychology as a *science*. Those who are eligible for membership are engaged in this work" (Cattell, 1895, p. 150; italics added). Thus, for psychology's pioneers, both in Germany and in the United States, the "new psychology" was to be identified with laboratory science. It gradually forged an identity separate from the disciplines of physiology and philosophy to become the independent discipline it is today.

For early psychologists, the new psychology was to be a science of mental life, the goal being to understand exactly how human consciousness was structured and/or how it enabled people to adapt to their environments. In order to study the mind scientifically, however, generally agreed-upon methods had to be developed and taught. Hence, students of the new psychology found themselves in laboratories learning the basic procedures for studying mental processes. Indeed, one of psychology's most famous early texts was a highly detailed laboratory manual published right after the turn of the 20th century by Cornell's eminent experimental psychologist, E. B. Titchener, a student of Wundt's. The manuals were in use in lab courses well into the 1930s and they were instrumental in training a generation of research psychologists (Tweney, 1987).

Although the particular research methods have changed considerably over the years, today's psychology departments continue this long tradition of teaching the tools of the trade to psychology students. From the very beginning of psychology's history, teaching research methodology has been the heart and soul of the psychology curriculum. Of course, students understandably tend to be suspicious of the argument that they are required to take a research methods course because "we've always done it that way." There should be other reasons to justify taking the course. There are.

Why Take This Course?

The most obvious reason for taking a course in research methods is to begin the process of learning how to do research in psychology. Our ideal scenario would be for you to become fascinated by research while you are taking this course, decide that you would like to do some, get your feet wet as an undergraduate (e.g., collaborate with a professor and perhaps present your research at a research conference), go to graduate school and complete a doctorate in psychology, begin a career as a productive researcher, get lots of publications and win lots of grants, achieve tenure, and eventually be named recipient of the APA's annual award for "Distinguished Scientific Contributions"! Of course, we are also realists and know that most psychology majors have interests other than doing research, most do not go on to earn doctoral degrees, most who earn doctorates do not become productive researchers, and very few productive scholars win prestigious grants or awards. If you won't be a famous research psychologist someday, are there still reasons to take this course? Certainly!

For one thing, a course in research methods (accompanied by a statistics course) provides a solid foundation for understanding the information you will encounter in other psychology courses in more specific topic areas (social, cognitive, developmental, etc.). Research has shown that students who do well in statistics and methods courses go on to have higher GPAs in their other psychology courses than students doing poorly, and that methodology course grades in particular are good predictors of the overall knowledge about psychology gained by students during their careers as psychology majors (Freng, Webber, Blatter, Wing, & Scott, 2011). Thus, it is no surprise that your psychology department requires you to take statistics and methodology courses, and usually wants you to take them early in your career as a psychology major. The difference between the methods course and other courses in the psychology curriculum is essentially the difference between *process* and *content*. The methods course teaches a *process* of acquiring knowledge about psychological phenomena that is then applied to all the specific *content* areas represented by other courses in the psychology curriculum. A social psychology experiment in conformity might be worlds apart in subject matter from a cognitive psychology study on eyewitness memory, but their common thread is research methodology—the manner in which researchers gain their knowledge about these phenomena. Fully understanding textbook descriptions of research in psychology is much easier if you know something about the methods used to arrive at the conclusions.

To illustrate, take a minute and look at one of your other psychology textbooks. Chances are that virtually every paragraph makes some assertion about behavior that either includes a specific description of a research study or at least makes reference to one. For example, Myers's (1980) social psychology text includes the following description of a study about the effects of violent pornography on male aggression (Donnerstein, 1980). Myers wrote that the experimenter "showed 120 . . . men either a neutral, an erotic, or an aggressive-erotic (rape) film. Then the men, supposedly as part of another experiment, 'taught' a male or female confederate some nonsense syllables by choosing how much shock to administer for incorrect answers. The men who had watched the rape film administered markedly stronger shocks – but only toward female victims" (Myers, 1990, p. 393). While reading this description, someone unfamiliar with experimental design might get the general idea, but someone familiar with methodology would also be registering that the study was at the very least a 2 (sex of the confederate) x 3 (film condition) between-subjects factorial design resulting in a type of interaction effect that takes precedence over any main effects; that the two independent variables (film type, victim gender) were both manipulated variables, thereby strengthening the causal interpretation of the results; and that the "victims" were not really shocked but were clued in to the purposes of the study (i.e., they were confederates). Also, the thoughts "I wonder what would happen if there was more of a delay between viewing the film and the learning part of the study?" or "I wonder how female participants would react in a replication of the study?" might also float through the mind of someone in tune with the kind of "what do we do for the next experiment?" thinking that accompanies knowledge of research methodology. By the end of this course, you will be familiar with all the language found in the aggression study we just described and you will also be asking those "next step" kinds of questions that researchers ask.

A second reason for taking experimental psychology is that even if you never collect a single piece of data after completing this course, knowledge of research methods will make you a more informed and critical thinker. Any good course in psychology will improve your critical thinking skills, but a methodology course will be especially effective at enhancing your skills in evaluating research and claims about psychology that appear to be based on research. Bensley (2008) defines critical thinking in psychology as a form of precise thinking "in which a person reasons about relevant evidence to draw a sound or good conclusion" (p. 128). This requires being able to judge the quality of the evidence used to support a claim, being fair and unbiased when examining conflicting claims, and drawing reasonable conclusions based on the evidence at hand. A research methods course will help you do all of these things better.

The need for critical thinking about psychology is clear. We are continually exposed to claims about behavior from sources ranging from the people around us who are amateur psychologists to media accounts ranging from the sublime (an account in a reputable magazine about research on the relationship between video-game playing and aggressiveness) to the ridiculous (the tabloid headlines you read while waiting in line to pay for groceries). While the latter can be dismissed without much difficulty (for most people), a professional writer unaware of the important distinction between experimental and correlational research might have penned the video game study. Consequently, the article might describe a correlational study hinting at cause and effect more than is justified, a mistake you'll have no difficulty recognizing once you have finished Chapter 9. Another example might be a claim that while under hypnosis, people can be transported back to the moment of their birth, thereby gaining insight into the origins of their problems. When you learn about "parsimonious" explanations in Chapter 3, you will be highly suspicious about such a claim and able to think of several alternative explanations for the reports given by patients about their alleged birth experiences. Similarly, you will learn to become skeptical about the claims made by those who believe the "subliminal" messages in the recordings they just downloaded are the cause of the weight they just lost, or by those who believe that their child's IQ can be raised by listening to classical music (the so-called "Mozart effect").

Third, there is a very practical reason for taking a research methods course. Even if you have no desire to become a research psychologist, you might like to be a psychology practitioner someday. Like researchers, practitioners must earn an advanced degree, either a master's degree or a doctorate. Even for future clinical psychologists, counselors, and school psychologists, graduate school almost certainly means doing some research, so a course in methodology is an obvious first step to learning the necessary skills. Furthermore, your chances of getting into *any* type of graduate program in the first place are improved significantly if you (a) earned good grades in undergraduate research methods and statistics courses and (b) were involved in doing some research as an undergraduate. As Kuther (2006) put it in *The Psychology Major's Handbook*, graduate admissions committees "want applicants who are interested in the program, have research experience, and have a background in statistics, methodology, and science" (p. 206). Furthermore, Norcross, Hanych, and Terranova (1996) examined the undergraduate courses most likely to be required for admission to graduate school, and found that the methods course was ranked second, just behind statistics, while specific content courses (e.g., developmental and abnormal psychology) lagged far behind and were not even required by many programs.[1]

Should you become a professional psychologist, your research skills will be essential. Even if you don't become an active researcher, you will need to keep up with the latest research in your area of expertise and to be able to read and critically assess research. Furthermore, good clinical work involves essentially the same kind of thinking that characterizes the laboratory scientist—hypotheses about a client's problems are created and tested by trying out various treatments, and the outcomes are systematically evaluated. Also, if you work for a social service agency, you may find yourself dealing with accreditation boards or funding sources and they will want to know if your psychological services are effective. As you will discover in Chapter 11, research evaluating program effectiveness touches the lives of many professional psychologists.

Only a minority of psychology majors become professional psychologists with advanced degrees, yet a research methods course can help develop the kinds of skills that employers look for in bachelor's level job applicants. By the time you have completed this course, for example, you should be better at critical and analytical thinking, precise writing, and logical argument. In addition, you will know how to analyze, summarize, and interpret empirical data, search for information in libraries and electronic databases (e.g., PsycINFO), and present the results of your research in a clear and organized fashion. Your computer skills will also improve—you will either learn or increase your existing skill with some statistical software package (e.g., SPSS) and you

[1] In an analysis of 1554 graduate programs, it was found that 85.2% "required" or "preferred" statistics. The percentages were 66.0% for the research methods course, 35.9% for "childhood/developmental," and 32.5% for "abnormal/psychopathology."

might also become more familiar with presentation software (e.g., PowerPoint). To learn more about the kinds of skills you will begin to develop in the methods course, you might take a peek ahead to the Epilogue and the section called "what I learned in my research methods course."

Finally, a course in research methods introduces you to a particular type of thinking. As mentioned above, other psychology courses deal with specific content areas and concentrate on what is known about topic X. The methods course, however, focuses more on the process by which knowledge of X is acquired. That process is centered on scientific thinking, and it is deeply ingrained in all research psychologists. Before detailing the features of the scientific way of thinking, however, let us first describe some of the other ways in which we arrive at our knowledge of the world.

Ways of Knowing

Take a moment and reflect on something that you believe to be true. The belief could be something as simple as the conviction that lobster should be eaten only in Maine, or it could be something as profound as the belief in a personal God. How do we arrive at such beliefs? Have we learned it from others we view as experts, or did we use logical reasoning, or did we base our knowledge of our beliefs on our own experiences? These three alternatives represent three ways of knowing described below: authority, reason, and empiricism. And none are without their flaws.

Authority

Whenever we accept the validity of information from a source that we judge to be an expert, then we are relying on **authority** as a source of our knowledge. As children we are influenced by and believe what our parents tell us (at least for a while), as students we generally accept the authority of textbooks and professors, as patients we take the pills prescribed for us by doctors and believe they will have beneficial effects, and so on. Of course, relying on the authority of others to establish our beliefs overlooks the fact that authorities can be wrong. Some parents pass along harmful prejudices to their children, textbooks and professors are sometimes wrong or their knowledge may be incomplete or biased, and doctors can miss a diagnosis or prescribe the wrong medicine. An important aspect of the attitude of a critical thinker is the willingness to question authority.

On the other hand, we do learn important things from authority figures, especially those who are recognized as experts in particular fields. Thus, we read *Consumer Reports*, we watch the Weather Channel, and we (sometimes) pay attention when the medical community cautions us about our chronic lack of exercise and poor eating habits. Also, it doesn't stretch the concept of authority to consider the giants in the arts and literature as authority figures who can teach us much about ourselves and others. Who can read Shakespeare or Dickens or Austen without gaining valuable insights about human nature?

Use of Reason

We sometimes arrive at conclusions by using logic and reason. For example, given the statements (sometimes called premises):

Primates are capable of using language.

Bozo the chimp is a primate.

It is logical for us to conclude that Bozo the chimp has the ability to use language. Can you see the problem here? The logic is flawless, but the conclusion depends on the truth of the first two statements. The second one might be OK and easy to verify, but the first one could be subject to considerable debate, depending, among other things, on how language is defined. Psycholinguists have been arguing about the issue for years. The key point is that the value of a logically drawn conclusion depends on the truth of the premises, and it takes more than logic to determine whether the premises have merit.

The American pragmatist philosopher Charles Peirce pointed out another difficulty with the use of reason and logic—it can be used to reach opposing conclusions. Peirce labeled the use of reason, and a developing consensus among those debating the merits of one belief over another, the **a priori method** for acquiring knowledge. Beliefs are deduced from statements about what is thought to be true according to the rules of logic. That is, a belief develops as the result of logical argument, *before* a person has direct experience with the phenomenon at hand (*a priori* translates from the Latin as "from what comes before"). Peirce pointed out that the *a priori* method was favored by metaphysical philosophers, who could reason eloquently to reach some truth, only to be contradicted by other philosophers who reasoned just as eloquently to the opposite truth. On the question of whether the mind and the body are one or two different essences, for instance, a "dualist" philosopher might develop a sophisticated argument for the existence of two fundamentally different essences, the physical and the mental, while a "monist" might develop an equally compelling argument that mental phenomena can be reduced to physical phenomena (e.g., the mind *is* the brain). The outcome of the *a priori* approach, Peirce argued, is that philosophical beliefs go in and out of fashion, with no real "progress" toward truth.

Empiricism

Another important way of coming to know things is through our experiences in the world. This is **empiricism**—the process of learning things through direct observation or experience, and reflection on those experiences. You will see shortly that asking "empirical questions" is an important component of scientific thinking, and there is certainly some truth in the old saying that "experience is the best teacher." Yet it can be dangerous to rely uncritically and solely on one's experiences when trying to determine the truth of some matter. The difficulty is that our experiences are necessarily limited and our interpretations of our experiences can be influenced by a number of what social psychologists refer to as "social cognition biases." One of these biases is the **confirmation bias**: a tendency to seek and pay special attention to information that supports one's beliefs, while ignoring information that contradicts a belief (Wason & Johnson-Laird, 1972). For instance, persons believing in extrasensory perception (ESP) will keep close track of instances when they were "thinking about Mom, and then the phone rang and it was her!" Yet they ignore the far more numerous times when (a) they were thinking about Mom and she didn't call, and (b) they weren't thinking about Mom and she did call. They also fail to recognize that if they talk to Mom about every two weeks, their frequency of "thinking about Mom" will increase near the end of the two-week interval, thereby increasing the chances of Mom actually calling. Confirmation bias often combines with another preconception called **belief perseverance** (Lepper, Ross, & Lau, 1986). Motivated by a desire to be certain about one's knowledge, it is a tendency to hold on doggedly to a belief, even in the face of evidence that would convince most people that the belief is false. It is likely that these beliefs form when the individual hears some "truth" being continuously repeated, in the absence of contrary information. Thus, many college students in the 1960s strongly believed in the idea of a generation gap and accepted as gospel the saying "Don't trust anyone over the age of 30." (Of course, these same people are now pushing 70 and some of them are deeply suspicious of anyone younger than 30). Strongly held prejudices include both belief perseverance and confirmation bias. Those with racist attitudes, for example, refuse to consider evidence disconfirming the prejudice and seek out and pay attention to information consistent with the prejudicial belief. They will argue that experience is indeed the best teacher and that their experience has taught them about the superiority of their own group and the inferiority of members of another group.

Another social cognition bias is called the **availability heuristic**, and it occurs when we experience unusual or very memorable events and then overestimate how often such events typically occur (Tversky & Kahneman, 1973). Thus, people who watch a lot of crime shows on TV misjudge their chances of being crime victims, and because spectacular plane crashes are given more attention in the media than car accidents, some people cannot believe the fact that air travel is considerably safer than travel by automobile. An example of an availability heuristic of relevance to students is what happens when students change their answers on multiple-choice tests. Many students believe that the most frequent outcome of answer changing is that an initially correct answer will be changed to a wrong one. Students tend to hold that belief because when such an event does occur, it is painful and hence memorable (availability heuristic), perhaps making the difference between an A and a B on a test. Also, once the belief starts to develop, it is strengthened whenever the same kind of outcome does occur (confirmation bias), and it doesn't take too many instances before a strong belief about answer changing develops (belief perseverance begins). It is not uncommon to hear students tell others not to change answers but to "go with your initial gut feeling," a phenomenon that Kruger, Wirtz, and Miller (2005) call the "first instinct" fallacy. The problem is that students overlook cases when they change from one wrong multiple-choice alternate to another wrong one, or when they change from a wrong alternative to the correct one. It is only the memorable situation, changing from a right to a wrong answer that damages their score ("I had it right! And I changed it!").

When Kruger et al. (2005) asked students (n = 1,561) to estimate the percentages of the various outcomes of answer changing on a multiple-choice test, these were the results:

Changing from wrong to right	→	33%
Changing from right to wrong	→	42%
Changing from wrong to wrong	→	24%

But when Kruger and his colleagues calculated the actual percentages, measured by looking at erasures on multiple choice tests taken by the same students, these were the results:

Changing from wrong to right	→	51%
Changing from right to wrong	→	25%
Changing from wrong to wrong	→	23%

This of course is a huge difference—students were holding onto a strong belief ("Don't change answers—go with your first instinct!"), a belief they thought was based solidly on their direct experience, and yet the belief was completely false.[2] If you are saying to yourself there is no way this can be true, and I suspect you might indeed be saying that to yourself, then you have some idea of the strength of the combined forces of confirmation bias, belief perseverance, and the availability heuristic. Our experiences can be an indispensable and important guide to life's difficulties, but we also need to be aware of their limits. Social cognition biases such as the ones described here (not to mention several others—check out any social psychology textbook) can work together to distort the beliefs about and our interpretations of experiences in the world.

[2] People who should know better also fall prey to this first instinct fallacy. Kruger et al. (2005) opened their article by quoting from a well-known GRE test preparation guide (*Barron's*)—"Exercise great caution if you decide to change an answer. Experience indicates that many students who change answers change to the wrong answer" (p. 725). They also referred to an earlier study by Benjamin, Cavell, and Shallenberger (1984), which showed that the majority of *faculty* at Texas A&M University surveyed also endorsed the first instinct fallacy.

The Ways of Knowing and Science

The most reliable way to develop a belief, according to Charles Peirce, is through the method of **science**. Its procedures allow us to know "real things, whose characters are entirely independent of our opinions about them" (Tomas, 1957, p. 25). Thus, Peirce believed that the chief advantage of science is in its objectivity—for Peirce, to be objective meant to avoid completely any human bias or preconception. Modern philosophers of science recognize that, because scientists are just as human as everyone else, the ideal of a pure objectivity among scientists is impossible. To some degree, they rely on authority, they often logically argue with each other in an *a priori* fashion, and they are prone to social cognition biases in the process of learning from their experiences.

Concerning bias, scientists sometimes hold on to a pet theory or a favored methodology long after others have abandoned it, and they occasionally seem to be less than willing to entertain new ideas. Charles Darwin once wrote half seriously that it might be a good idea for scientists to die by age 60, because after that age, they "would be sure to oppose all new doctrines" (cited in Boorstin, 1985, p. 468). On the other hand, the historian of science Thomas Kuhn (1970) argued that refusing to give up on a theory, in the face of a few experiments questioning that theory's validity, can have the beneficial effect of ensuring that the theory receives a thorough evaluation. Thus, being a vigorous advocate for a theory can ensure that it will be pushed to its limits before being abandoned by the scientific community. The process by which theories are evaluated, evolve, and sometimes die will be elaborated in Chapter 3.

Research psychologists can also be influenced by authority. The "authorities" are usually other scientists, and experts are certainly more likely to be reliable sources than not. Nonetheless, researchers know better than to assume automatically that something is true simply because a reputable scientist said it was true. Rather, scientists are normally guided by the motto engraved on the entrance to the headquarters of the British Royal Society—"Nullius in Verba"—which encourages them to "take nobody's word for it; see for yourself" (cited in Boorstin, 1985, p. 394). Of course, "seeing for yourself" opens up the dangers of uncritically relying on experience, but scientists tend to be rather good at critical thinking.

Peirce's *a priori* method (the use of reason) is frequently found in science to the extent that scientists argue with each other, trying to reach a rational consensus on some issue, but often failing to do so (e.g., whether the computer provides a useful metaphor for memory). As you will see in Chapter 3, they also rely on the rules of logic and inductive/deductive reasoning to develop ideas for research and to evaluate research outcomes. Although scientific thinking includes elements of the nonscientific ways of knowing described thus far, it has a number of distinct attributes. It is to the nature of science that we now turn.

Self Test 1.1

1. Even if you never get involved in research after taking the research methods course, why is taking a research methods course valuable?
2. If you fail to question anything in this textbook, you will be relying too heavily on _________ as a way of knowing.
3. Some students think they should never change answers on multiple-choice tests. What does this have to do with the availability heuristic?

Science as a Way of Knowing

The way of knowing that constitutes science in general and psychological science in particular involves a number of interrelated assumptions and characteristics. First, researchers assume **determinism** and **discoverability**. Determinism simply means that events, including psychological ones, have causes, and discoverability means that by using agreed-upon scientific methods, these causes can be discovered with some degree of confidence. In psychology, we ultimately would like to know what causes behavior (determinism), and it is with the tools of science that we can discover those causes (discoverability). Even with the best of methods, research psychologists do not expect to predict psychological phenomena with 100% certainty, but they have faith that psychological phenomena occur with some regularity and that the regularities can be investigated successfully. Let us examine the determinism assumption in more detail. This will be followed by a discussion of the other attributes of science as a way of knowing.

Science Assumes Determinism

Students are often confused after reading that psychologists regard human behavior as "determined." They sometimes assume this means "predestined" or "predetermined," or that "determinism" is contrasted with "free will." These are not the definitions of determinism that scientists use. A believer in absolute predestination thinks that every event is determined ahead of time, perhaps by God, and develops a fatalistic conviction that one can do little but accept life as it presents itself. However, the traditional concept of determinism, as used in science, contends simply that all events have causes. Some philosophers have argued for a strict determinism, which holds that the causal structure of the universe enables the prediction of all events with 100% certainty, at least in principle. Most scientists, influenced by 20th-century developments in physics and the philosophy of science, take a more moderate view that could be called probabilistic or **statistical determinism**. This approach argues that events can be predicted, but only with a probability greater than chance. Research psychologists take this position and use this definition of determinism in their science.

The concept of determinism, even the "less than 100%" variety, is troubling because it seems to require that we abandon our belief in free will. If every event has a cause, so the argument goes, then how can one course of action be freely chosen over another? The psychologist would reply that if determinism is not true at least to some degree, then how can we ever know anything about behavior? Imagine for a moment what it would be like if human behavior was completely unpredictable. How could you decide whether to marry Ned or Ted? How could you decide whether or not to take a course from Professor Jones?

Of course, there are multiple factors influencing behavior, and it is difficult to know for sure what someone will do at any one moment. Nonetheless, behavior follows certain patterns and is clearly predictable. For example, because we know that children will often do things that work effectively for them, it is not hard to predict a tantrum in the toy department of a crowded store if that behavior has yielded toys for a child in the past. And because behavior learned in one setting tends to "generalize" to similar environments, it isn't hard to predict a tantrum in Wal-Mart for the child whose tantrums have worked effectively in Target.

Most research psychologists believe that the issue about the existence of free will cannot be settled one way or the other by science. Rather, whether the choices we make in life are freely made or not is a philosophical matter, and our personal belief about free will must be an individual decision, arrived at through the use of reason (perhaps supplemented with reflection on our experiences and/or the ideas of authority figures). The best that psychologists can do is to examine scientifically such topics as (a) the extent to which behavior is influenced by a strong belief in free will, (b) the degree to which some behaviors are more "free" than others (i.e., require more conscious decision making), and (c) what the limits might be on our "free choices" (Baumeister, 2008). As just one example of this line of research, Vohs and Schooler (2008) argued that a belief in free will has value, perhaps increasing the chances that people will behave ethically. In two studies, they found that encouraging a belief in determinism increased the tendency for subjects to cheat on academic-type tasks, whereas subjects believing in free will and reading statements promoting free will were less likely to cheat.

Science Makes Systematic Observations

A major attribute of science as a way of knowing is the manner in which science goes about the business of searching for regularities in nature. All of us do a lot of observing in our daily lives, and we draw conclusions about things based on those observations. But we also know, from the earlier discussion of empiricism as a way of knowing, that experience is susceptible to such biases as confirmation bias, belief perseverance, and the availability heuristic. Science also bases its findings on observations, but they are made much more systematically than our everyday observations. The scientist's systematic observations include using (a) precise definitions of the phenomena being measured, (b) reliable and valid measuring tools that yield useful and interpretable data, (c) generally accepted research methodologies, and (d) a system of logic for drawing conclusions and fitting those conclusions into general theories. The rest of this book is an elaboration of the sentence you just read.

Science Produces Public Knowledge

Another important characteristic of science as a way of knowing is that its procedures result in knowledge that can be publicly verified. This was the attribute that Peirce found most appealing about science—its **objectivity**. For Peirce, being objective meant eliminating such human factors as expectation and bias. The objective scientist was believed to be almost machine-like in the search for truth. Today, however, nobody believes that scientists can separate themselves from their already-existing attitudes, and to be objective does not mean to be devoid of such normal human characteristics. Rather, an objective observation, as the term is used in science, is simply one that can be verified by more than one observer. In science this usually takes the form of defining the terms and research procedures precisely enough so that any other person can repeat the study, presumably achieving the same observable outcome. That is, science produces knowledge that is public knowledge. This process of repeating a study to determine if its results occur reliably is called "replication" and you will learn more about it in Chapter 3. In general, as results are replicated, public confidence in the reality of some psychological phenomenon is increased. On the other hand, questions are raised when results cannot be replicated. As you will learn in the next chapter, a failure to replicate is also how scientific fraud is sometimes suspected and then uncovered.

Of course, in order to repeat a study, one must know precisely what was done in the original one. This is accomplished by means of a prescribed set of rules for describing research projects. These rules are presented in great detail in the *Publication Manual of the American Psychological Association* (American Psychological Association, 2010), a useful resource for anyone reporting research results or writing any other type of psychology paper. Appendix A, a guide to writing a research report in APA format, is based on the manual and provides a good introduction to writing the report.

Objectivity in psychological science has been a problem historically. When psychology first emerged as a new science, it defined itself as the "science of mental life" and one of its early methods was called **introspection**. This procedure varied considerably from one laboratory to another, but it was basically a form of precise self-report. Participants in an experiment would perform some task and then provide a detailed description of their conscious experience of the task. To give you some sense of what introspection was actually like, read Box 1.1 before going any further. It shows you an example of a verbatim introspective description in a 1913 experiment on attention, and it shows how the progress of science occurred when introspection was later abandoned for more objective measures of behavior.

BOX 1.1 ORIGINS—A Taste of Introspection

The following introspective account is from a 1913 study by Karl Dallenbach dealing with the phenomenon of attention. Introspectors were instructed to listen to two metronomes set at different speeds and to count the number of beats between coincident beats (i.e., both metronomes hitting at the same instant). While counting, they were also asked to perform some other task, such as continuously adding numbers out loud. Needless to say, these tasks severely tested the limits of attention. After finishing a session, one introspector reported:

> The sounds of the metronomes, as a series of discontinuous clicks, were clear in consciousness only four or five times during the experiment, and they were especially bothersome at first. They were accompanied by strain sensations and unpleasantness. The rest of the experiment my attention was on the adding, which was composed of auditory images of the numbers, visual images of the numbers, sometimes on a dark gray scale which was directly ahead and about three feet in front of me. . . . When these processes were clear in consciousness, the sounds of the metronomes were very vague or obscure. (Dallenbach, 1913, p. 467)

Notice that the introspector attempted to describe everything that happened in consciousness while performing the task, including sensory events ("strain"), emotion ("unpleasant"), and imagery, both auditory and visual. Also, the difficulty in keeping multiple tasks equally "clear in consciousness" led Dallenbach to conclude that attention was severely limited, a finding later rediscovered by later research on "selective" attention (e.g., Broadbent, 1958).

The problem with introspection was that although introspectors underwent rigorous training that sought to eliminate bias in their self-observations, the method was fundamentally subjective—I cannot verify your introspections and you cannot verify mine. The problem was articulated nicely by John B. Watson, in a paper that came to be known as the "Behaviorist Manifesto" (Watson, 1913). As he put it:

> Take the case of sensation. A sensation is defined in terms of its attributes. One psychologist will state with readiness that the attributes of a visual sensation are *quality, extension, duration*, and *intensity*. Another will add *clearness*. Still another that of *order*. I doubt if any one psychologist can draw up a set of statements describing what he means by sensation which will be agreed to by three other psychologists of different training. (p. 164, emphasis in the original)

If psychology was to be truly "scientific," Watson argued, it needed to drop introspection and measure something that was directly observable and could therefore be verified objectively (i.e., by two or more observers). For Watson the answer was simple: just measure behavior. His argument that the basic data of psychology ought to be observable and measurable behavioral acts earned Watson the title of founder of behaviorism as a school of thought. Today, the term *behavior* is part of psychology's definition in every introductory psychology textbook.

With behavior as the data to be measured, the modern researcher investigating attention would not ask for detailed introspective accounts, as Dallenbach did in Box 1.1, but would design an experiment in which conclusions about attention could be drawn from some easily observed behavior in the Dallenbach task, such as the number of addition errors made while the participant was trying to keep track of the metronome activity. Presumably, two independent observers could agree on the number of errors that occurred in the task, making the experiment open to public verification.

Science Produces Data-Based Conclusions

Another attribute of science as a way of knowing is that researchers are **data driven**. That is, like the character in the middle at the bar in Figure 1.1, who is undoubtedly a scientist of some kind, research psychologists expect conclusions about behavior to be supported by evidence gathered through some systematic procedure. For instance, a claim made by a college admissions director that “this year’s incoming class is better prepared than any in recent memory” (an annual claim at some schools) would compel the scientific thinker to respond, “Let’s see the data for this year and the past few years,” and “What do you mean by better prepared?” Furthermore, researchers try to judge whether the data given to support some claim are adequate for the claim to be made. Hence, if someone asserts that talking on a cell phone adversely affects driving, the scientist immediately begins to wonder about the type and amount of data collected, how the terms were defined in the study (e.g., driving performance), the exact procedures used to collect the data, the type of statistical analysis that was done, and so on.

This attitude about data can be detected easily in research psychologists. They even find themselves thinking about how data might bear on the problems they encounter in daily living. Even a neighbor’s offhand observation about the tomato crop being better this year might generate in the researcher’s mind a host of data-related questions to test the claim (How exactly did you count the tomatoes during the past 2 years? Did you measure the number picked per day or the number that ripened per day? How did you define “ripe”? What do you mean by “better”?). Of course, there are certain hazards resulting from this kind of thinking, including a tendency for the neighbor to begin avoiding you. Sometimes the “driven” (as in compelled) part of the term “data-driven” seems to be the operative term.

“Are you just pissing and moaning, or can you verify what you’re saying with data?”

FIGURE 1.1
On the importance of data-based conclusions.

A personification of the data-driven attitude taken to extremes can be found in the life of Sir Francis Galton, a 19th-century British jack-of-all-sciences, whose interests ranged from geography to meteorology to psychology. His importance for correlational research will be examined in Chapter 9. Galton was obsessed with the idea of collecting data and making data-based conclusions. Thus, he once measured interest in various theater productions by counting the number of yawns that he could detect during performances; he studied association by counting the number of related ideas occurring to him on his morning walks; and he collected data on species differences and age-related hearing loss by inventing a device, called the "Galton whistle," that produced sounds of various pitches (Galton, 1883/1948).

Galton's (1872) most unusual attempt to draw a data-based conclusion was a controversial study on the "efficacy of prayer." Like his cousin, Charles Darwin, Galton was skeptical about religion and decided to test empirically the notion that prayers "worked." If prayers were effective, he reasoned, then sick people who pray for a return to health should recover sooner than those who do not. Similarly, people who do a lot of praying for a living (i.e., the clergy) or who are the object of a great deal of prayer (i.e., the king and queen of England) should live longer than the general population. None of these predictions were supported by the data, however. For instance, by digging through biographical dictionaries, Galton found that eminent members of the clergy lived for an average of 66.42 years and members of the royal family lasted 64.04 years; lawyers, on the other hand (presumably less likely to be the object of prayer), made it to a virtually identical average of 66.51 years (data from Forrest, 1974, p. 112). Galton was understandably criticized for his rather simplistic idea of the purpose of prayer, and his article on prayer was initially rejected (three times) as being "too terribly conclusive and offensive not to raise a hornet's nest" (cited in Forrest, 1974, p. 111), but the study certainly illustrates a conviction for drawing data-based conclusions.

Science Produces Tentative Conclusions

Related to the data-driven attitude that characterizes researchers is the recognition that conclusions drawn from data are always tentative, subject to revision based on future research. That is, science is a self-correcting enterprise and its conclusions are not absolute, yet there is confidence that research will eventually get one ever closer to the truth. The attitude was nicely described by Damasio (1994), in the context of research on the brain.

> I have a difficult time seeing scientific results, especially in neurobiology, as anything but provisional approximations, to be enjoyed for a while and discarded as soon as better accounts become available. But skepticism about the current reach of science, especially as it concerns the mind, does not imply diminished enthusiasm for the attempt to improve provisional explanations. (p. xviii)

The tentative nature of scientific research is a feature of scientific thinking that is often difficult for the general public to understand; people seem to believe that the outcome of well-executed scientific research will be authoritative and the final answer to some question. This belief is the basis for the frustration often felt when some new finding reported in the news seems to contradict what was reported just a few years before. You can probably think of many examples that have been in the news. For example, consider coffee and its main ingredient, caffeine, America's favorite drug. A Google search on the topic quickly yields newspaper headlines like the following: "Conflicting Views on Caffeine in Pregnancy" (*New York Times*, 17 July 2001); "Sorting out Coffee's Contradictions" (*New York Times*, 5 August 2008); and "Coffee: Good for Us? Or Bad for Us? Two New Studies Disagree" (*Los Angeles Times*, 19 August 2013). Reading these stories, one learns that coffee drinking by pregnant women might result in babies with low birth weight, but maybe it won't; that coffee can increase the risk for developing high blood pressure, but maybe it won't; or that coffee drinking can increase the chances of getting liver cancer, but maybe not. Coffee drinkers (i.e., most of us) reading these articles might be inclined to throw up their hands and say, "Why can't they (scientists) make up their minds?" The frustration is reasonable, but it is based on a fundamental misunderstanding of science. It is true that some findings have a greater degree of certainty than others, because they are based on a large body of evidence accumulated over a long period of time (e.g., the link between smoking and heart disease), but all findings are subject to rethinking, based on new research. Compared to most people, scientists have a relatively high tolerance for ambiguity and a willingness to be patient with the progress of science. In the long run, scientists have faith that the proficient use of science will lead to increasing confidence about the truth of some phenomenon.

The tentative nature of science contrasts sharply with the nonscientific thinking described in the previous section of this chapter. Beliefs not based in science tend to be resistant to change, because they bring social cognition biases into play. Beliefs rooted in scientific methodology, however, are always subject to change based on new data. Individual scientists might be reluctant to give up on their own data easily, but science as a whole proceeds because new information, if based on good science and replicated, eventually cannot be ignored. Finally, there is an important lesson here for everyday critical thinking—we should always be open to new data and new ideas, willing to change our minds in the face of good (i.e., scientifically sound) evidence.

Science Asks Answerable Questions

As mentioned earlier, *empiricism* is a term that refers to the process of learning things through direct observation or experience. **Empirical questions** are those that can be answered through the systematic observations and techniques that characterize scientific methodology. They are questions that are precise enough to allow specific predictions to be made. As you will learn in Chapter 3, asking questions is the first step of any research endeavor. How to develop a good empirical question and convert it into a testable hypothesis will be one theme of that chapter.

We can begin to get an idea about what constitutes empirical questions, however, by contrasting them with questions that cannot be answered empirically. For example, recall that Peirce used the mind-body question to illustrate the *a priori* method (use of reason). Philosophers argued both sides of the question for many years (they're still at it!), and Peirce wasn't optimistic about the issue ever being resolved. Whether the mind and the body are two separate essences or one is simply not an empirical question. However, a number of empirical questions *can* be asked that are related to the mind-body issue. For instance, it is possible to ask about the influence of mental activity (mind) on physical health (body) by asking the empirical question "What are the effects of psychological stress on the immune system?" Also, it is possible to investigate the body's influence on mental states by asking how physical fatigue affects performance on some task.

Science Develops Theories That Can Be Falsified

When designing research studies, an early step in the process is to reshape the empirical question into a *hypothesis*, which is a prediction about the study's outcome. That is, prior to having empirical data, the hypothesis is your best guess about the answer to your empirical question. For the two empirical questions just asked about the mind-body issue, for instance, we might develop these hypotheses:

- Because students experience high levels of stress during final exam week, they will be more likely to become ill if they are exposed to a virus than students not exposed to a virus.
- Students asked to exercise vigorously for an hour will perform more poorly on a test of creative problem solving than students not asked to exercise.

You will notice that empirical questions are just that, questions, whereas hypotheses are statements about what a scientists think may occur in a particular situation.

As you will learn in Chapter 3, hypotheses sometimes develop as logical deductions from a **theory**, which is a set of statements that summarize what is known about some phenomena and propose working explanations for those phenomena. A critically important attribute of a good theory is that it must be precise enough so that it can be refuted, at least in principle. This concept is often referred to as **falsification** (elaborated in Chapter 3—you could take a look ahead to Box 3.2 for a great historical example of falsification). That is, theories must generate hypotheses producing research results that could come out as the hypothesis predicts (i.e., support the hypothesis and increase confidence in the theory) or could come out differently (i.e., fail to support the hypothesis and raise questions about the theory). Research that consistently fails to support hypotheses derived from a theory eventually calls a theory into question and can lead to its modification or outright abandonment.

To sum up this section on science as a way of knowing, research psychologists can be described as "skeptical optimists." They are open to new ideas and optimistic about using scientific methods to test these ideas, but at the same time they are tough-minded—they won't accept claims without good evidence. Also, researchers are constantly thinking of ways to test ideas scientifically, they are confident that truth will emerge by asking and answering empirical questions, and they are willing (sometimes grudgingly) to alter their beliefs if the answers to their empirical questions are not what they expected.

One final point. Although we have been describing the attitudes and behaviors of psychological scientists, it is important to realize that virtually all of the points made in this section of the chapter are relevant to you as a developing critical thinker. To reiterate a point made earlier, it is not essential for you to become a researcher for the lessons of this book to have value for you. All of us could benefit from using the attributes of scientific thinking to be more critical and analytical about the information we are exposed to every day.

Self Test 1.2

1. Textbook definitions of psychology always include the term "behavior." What does this have to do with the concept of objectivity?
2. What is an empirical question? Give an example.
3. What is a hypothesis? Give an example.

Psychological Science and Pseudoscience

Because everyone is interested in human behavior, it is not surprising that many claims are made about its causes and inner workings. Many of those claims are based on legitimate scientific inquiry, of course, following the rules of the game that you will learn about in this text and carried out by the skeptical optimists we just described. That is, psychologists know a fair amount about behavior and mental life as a result of relying on the kinds of thinking and the specific methods that characterize legitimate science. However, many claims are made in the name of psychological science using methods and ways of thinking that are not truly scientific but merely pseudoscientific ("pseudo" is from the Greek word for "false"). In general, the term **pseudoscience** is applied to any field of inquiry that appears to use scientific methods and tries hard to give that impression, but is actually based on inadequate, unscientific methods and makes claims that are generally false or, at best, overly simplistic. The Sidney Harris cartoon in Figure 1.2 portrays an

FIGURE 1.2
The unfortunate popularity of pseudoscience.

unfortunate truth about pseudoscience—its popular appeal. What differentiates true science from pseudoscience is an important thing to know for a critical thinker in psychology.

Recognizing Pseudoscience

Those living in the late 19th-century could send away to the New York firm of Fowler and Wells for a "Symbolic Head and Phrenological Map" for 10 cents. For another $1.25, the head and map would be accompanied by a copy of *How to Read Character: A New Illustrated Handbook of Phrenology and Physiognomy* (Anonymous Advertisement, 1881). Thus equipped, people would then be in a position to measure character (theirs or that of others) "scientifically" through an analysis of skull shape.

Even today in the 21st century, we can visit any one of dozens of websites and learn about "graphology," the so-called science of analyzing personality by examining handwriting. At one site, for instance, for $29.95, you can buy a "Basic Steps to Graphoanalysis" kit, complete with workbook and DVD. Thus equipped, you would then be in a position to measure personality (yours or that of others) "scientifically" through an analysis of handwriting.

As these two examples suggest, people are willing to pay for self-knowledge, especially if the methods appear to be scientific and take little effort to implement and understand. Both 19th-century phrenology and 21st-century graphology are pseudoscientific, however, and both illustrate the main features of pseudoscience—they try hard to associate with true science, they rely primarily on anecdotal and testimonial evidence, they sidestep the all-important falsification criterion, and they take complex phenomena (e.g., character, personality) and try to convince you these phenomena can be understood by relying on simple-to-understand concepts (e.g., head shape, handwriting shape).

Associates with True Science

Proponents of pseudoscience do everything they can to give the appearance of being scientific. In some cases, the origins of a pseudoscience can be found in true science; in other instances, the pseudoscience confuses its concepts with genuine scientific ones. Phrenology illustrates the former, graphology the latter.

Phrenology originated in legitimate attempts to demonstrate that different parts of the brain had identifiably distinct functions, and it is considered one of the first systematic theories about the localization of brain function (Bakan, 1966). Phrenologists believed that (a) different personality and intellectual attributes (“faculties”) were associated with different parts of the brain (see Figure 1.3), (b) particularly strong faculties resulted in larger brain areas, and (c) skull measurements yielded estimates of the relative strengths of faculties. By measuring skulls, therefore, one could measure the various faculties that made up one’s personality.

Phrenology remained popular into the early years of the 20th-century, even though it had been discredited in a brilliant series of studies by the French physiologist Pierre Flourens by the mid-1800s (see Box 1.2). Yet in the second half of the 19th century, despite being abandoned by scientists, phrenology as a business enterprise flourished—phrenological societies were formed, popular journals were established, and phrenological analysis was used for everything from choosing a career to hiring an honest servant. Even if a theory is discredited within the scientific community, then, it can still find favor with the public. This creates special problems for psychology as a science, because it isn’t difficult for virtually any type of theory about human behavior to have some popular appeal. The graphology business is a good recent example.

Courtesy of Dr. C. James Goodwin

FIGURE 1.3
A phrenological skull with faculties identified.

BOX 1.2 CLASSIC STUDIES—Falsifying Phrenology

In 1846, a brief volume (144 pages) with the title *Phrenology Examined* appeared. Its author was Pierre Flourens (1794–1867), a distinguished French physiologist and surgeon known for demonstrating the role of the ear's semicircular canals in balance, for locating the respiratory center in the medulla oblongata, and for discovering the anesthetic properties of chloroform (Kruta, 1972). He was also phrenology's worst enemy. He certainly did not mince words, declaring:

> The entire doctrine of [phrenology] is contained in two fundamental propositions, of which the first is, that understanding resides exclusively in the brain, and the second, that each particular faculty of the understanding is provided in the brain with an organ proper to itself.
>
> Now, of these two propositions, there is certainly nothing new in the first one, and perhaps nothing true in the second one. (Flourens, 1846/1978, p. 18)

To test the phrenologists' claims, Flourens took an experimental approach to the problem of localization, using the method of *ablation*. Rather than wait for natural experiments to occur in the form of accidental brain damage, Flourens removed specific sections of the brain and observed the effects. If the result of an ablation is an inability to see, then presumably the area of the removed portion has something to do with vision.

Flourens's attack on phrenology consisted of showing that specific areas of the brain that were alleged by phrenologists to serve one function in fact served another function, and that the cerebral cortex operated as an integrated whole rather than as a large collection of individual faculties located in specific places. One focus of his research was the cerebellum. To the phrenologists, this portion of the brain controlled sexual behavior and was the center of the faculty of "amativeness." In his celebrated *Outlines of Phrenology*, for instance, Johann G. Spurzheim (1832/1978) argued that sexuality "appears with the development of this part, and is in relation to its size" (p. 28). Apparently thinking of some anecdotal data, Spurzheim pointed out that sometimes the cerebellum "is of great magnitude in children, and then its special function, the propensity we treat of, appears in early life" (p. 28).

Flourens would have none of it. First, he ridiculed the circular logic of assigning "faculties" to a certain behavior and then explaining that same behavior by pointing to the faculties:

> [W]hat sort of philosophy is that, that thinks to explain a fact by a word? You observe . . . a penchant in an animal . . . a taste or talent in a man; *presto*, a particular faculty is produced for each one of the peculiarities, and you suppose the whole matter to be settled. You deceive yourself; your *faculty* is only a *word*,—it is the name of a fact,—and all the difficulty [of explanation] remains where it was before. (Flourens, 1846/1978, p. 39; italics in the original)

Flourens had little trouble ruling out (falsifying) the idea that the cerebellum had anything to do with sexual motivation. By carefully removing portions of the cerebellum, he showed that it was the center of motor coordination. Thus, pigeons deprived of the organ were unable to coordinate wing movements in order to fly, and dogs were unable to walk properly and were observed staggering, falling down, and bumping into objects they could normally avoid. Sexual motivation was unaffected. With other animals, Flourens removed varying amounts of the cerebral cortex and found a general relationship between the amount destroyed and the seriousness of the ensuing problem. He could find no indication of distinct functions ("faculties") residing in specific areas of the cortex.

Flourens effectively destroyed phrenology, but the issue of localization of function did not by any means disappear, and other physiologists soon demonstrated that the cortex had a greater degree of localization than Flourens was willing to grant. The French surgeon Paul Broca, for example, demonstrated that a relatively small area of the left frontal lobe of the cortex (later named for him), seemed to control the production of speech. For more on this issue of localization, take your department's courses in history and systems of psychology and/or biological psychology.

As for graphology, it has an even longer history than phrenology, dating at least as far back as the 17th century, when an Italian physician named Camillo Baldi wrote *Treatise on a Method to Recognize the Nature and Quality of a Writer from His Letters* (Nickell, 1922a). Various techniques for assessing handwriting developed over the years, and there are several modern versions, all having in common the belief that a close analysis of the components of handwriting will reveal stable personality traits. Graphology has an intuitive appeal, because handwriting styles do tend to be unique to the individual, so it is natural to assume that the style reflects something about the person—extroverts might write with larger letters than introverts, for instance. Graphologists have been employed in a number of settings, used by businesses for employee selection, for instance.

Advocates for graphology try to associate with true science in two different ways. First, there is a fairly high degree of complexity to the analysis itself, with measurements taken of such variables as slant, letter size, pen pressure, spacing between letters, etc. With actual physical measurements being made, one gets the impression of legitimacy. After all, science involves measuring things. Second, graphologists often confuse their pseudoscience with the legitimate science of document analysis, performed by professionals called "questioned document examiners" (Nickell, 1992b). This latter procedure is a respected branch of forensic science, involving the analysis of handwriting for identification purposes. That is, the document analyst tries to determine whether a particular person wrote or signed a specific document. This is accomplished by getting a handwriting sample from that person and seeing if it matches the document in question. The analyst is not the least bit interested in trying to assess personality from the handwriting. Yet graphologists sometimes point to the work of document examiners as a verification of the scientific status of their field.

Relies on Anecdotal Evidence

A second feature of pseudoscience, and one that helps explain its popularity, is the reliance on and uncritical acceptance of **anecdotal evidence**, specific instances that seem to provide evidence for some phenomenon. Thus, phrenology data consisted mostly of a catalog of examples: a thief with a large area of "acquisitiveness," a priest with an overdeveloped bump for "reverence," a prostitute with excessive "amativeness." Graphology advocates use the same approach. Their websites are filled with testimonials from people have had their handwriting analyzed and have been amazed at how accurate the graphologist's description of them appears to be. Anecdotal evidence in the form of testimonials has great appeal to the uncritical reader.

There is nothing wrong with accumulating evidence to support a theory; even anecdotal examples like the ones mentioned are not automatically disqualified. The problem occurs when one relies heavily on anecdotes or makes more of them than is warranted. The difficulty is that anecdotal evidence is selective; examples that don't fit are ignored (you might recognize this as another example of a confirmation bias). Hence, there may be some thieves with a particular skull shape, but in order to evaluate a specific relationship between skull configuration and thievery, one must know (a) how many people who are thieves do not have the configuration, and (b) how many people who have the configuration aren't thieves. Without having these two pieces of information, there is no way to determine if there is anything unusual about a particular thief or two with a particular skull shape. The identical problem occurs with graphology—the websites never report cases of people being given handwriting-based personality assessments that were wide of the mark.

One other reason to distrust a glowing testimonial is that it often results from a phenomenon familiar to social psychologists—**effort justification** (Aronson & Mills, 1959). Following from Leon Festinger's theory of cognitive dissonance (elaborated in the Chapter 3 discussion about theory), the idea is that after people expend significant effort, they feel compelled to convince themselves that the effort was worthwhile. After spending $30 on a handwriting analysis package, we don't like to think that we've thrown away hard-earned money and wasted valuable time.

To reduce the discomfort associated with the possibility that we've been had, we convince ourselves that the investment of time and money was a good one. That is, we justify the effort or cost we just expended by thinking it was worth it.

Sidesteps the Falsification Requirement

As you learned earlier in this chapter, one of the hallmarks of a good scientific theory is that it is stated precisely enough to be put to the stern test of falsification. In pseudoscience this does not occur, even though on the surface it would seem that both phrenology and graphology would be easy to falsify. Indeed, as far as the scientific community is concerned, falsification has occurred for both. As you know, Flourens effectively discredited phrenology (at least within the scientific community), and the same has occurred for graphology. Professional graphologists claim to have scientific support for their craft, but the studies are inevitably flawed. For example, they typically involve having subjects produce extensive handwriting samples, asking them to "write something about themselves." The content, of course, provides clues to the person. The graphologist might also interview the person before giving the final personality assessment. In addition, the so-called *Barnum effect* can operate. Numerous studies have shown that if subjects are given what they think is a valid personality test (but isn't) and are then given a personality description of themselves, filled with a mix of mostly positive traits, they will judge the analysis to be a good description of what they are like. This occurs even though *all* the subjects in a Barnum effect study get the exact same personality description, regardless of how they have filled out the phony personality test! So it is not difficult to imagine how a graphologist's analysis of a person might seem fairly accurate to that person. However, the proper study of graphology's validity requires (a) giving the graphologist several writing samples about topics having nothing to do with the subjects participating in the study (e.g., asking subjects to copy the first three sentences of the Declaration of Independence), (b) assessing the subjects' personality with recognized tests of personality that have been shown to be reliable and valid (concepts you'll learn more about in Chapter 4), and then (c) determining whether the graphologist's personality descriptions match those from the real personality tests. Graphology always fails this kind of test (Karnes & Leonard, 1992).

Advocates of pseudosciences such as phrenology and graphology have had to face the skepticism of legitimate scientists. Not all thieves have bumps in just the right places and not everyone with tightly cramped handwriting is tight with their money. Apologists respond to these threats rather creatively. Instead of allowing an apparent contradiction to damage the theory, they sidestep the problem by rearranging the theory a bit or by adding some elements to accommodate the anomaly. Consequently, the apparent falsification winds up being touted as further evidence in support of the theory! For example, if a known pacifist nonetheless had a large area of destructiveness, a clever phrenologist would find even larger areas of cautiousness, benevolence, and reverence, and these would be said to offset or suppress the violent tendencies. Likewise, when responding to a case where a person was found to be a big spender, even with tightly cramped handwriting, the graphologist would look to some other aspects of the handwriting (remember, a wide range of factors are measured) to explain away the apparent anomaly ("yes, the handwriting is cramped, but the extreme slant and specific looping of the g's and p's offsets that cramping, and is indicative of a certain looseness with money"). Or the graphologist might say the big spender is unconsciously trying to disguise the tendency by writing in a way that is opposite to the trait.

Thus, for pseudoscience, any contradictory outcome can be explained or, more accurately, explained away. Yet a theory that explains all possible outcomes fails as a theory because it can never make specific predictions. If a pacifist can have either a large or a small area of destructiveness, how can we use skull shape to predict whether someone will be a pacifist? If cramped writing may or may not indicate stinginess, how can behavior be predicted from the writing? In general, if a theory is beyond the reach of the strong test of falsification, and is therefore incapable of making predictions, it is of no value.

Another way that falsification is sidestepped by pseudoscience is that research reports in pseudoscientific areas are notoriously vague and they are never submitted to reputable journals with stringent peer review systems in place. As you recall, one of science's important features is that research produces public results, reported in books and journals that are available to anyone. More important, scientists describe their research with enough precision that others can replicate the experiment if they wish. This does not happen with pseudoscience, where the research reports are usually vague or incomplete and, as seen earlier, heavily dependent on anecdotal support.

Reduce Complex Phenomena to Overly Simplistic Concepts

A final characteristic of pseudoscience worth noting is that these doctrines take what is actually a very complicated phenomenon (the nature of human personality) and reduces it to overly simplistic concepts. This, of course, has great consumer appeal, especially in psychology. Trying to figure out and improve behavior is a universal human activity, and if the process can be simplified, either by measuring someone's head, interpreting someone's handwriting, or determining someone's astrological sign, then many people will be taken in by the apparent ease of the explanations. Please note that the actual simplicity of the explanatory concepts is often masked by an apparent complexity of the measuring devices used in many of the pseudosciences. Thus, the phrenologists went through an elaborate set of skull measurements to measure faculties and graphologists measure dozens of features of handwriting.

In sum, pseudoscience is characterized by (a) a false association with true science, (b) a misuse of the rules of evidence by relying excessively on anecdotal data, (c) a lack of specificity that avoids a true test of the theory, and (d) an oversimplification of complex processes. Perhaps because of our enormous interest in behavior, pseudoscientific approaches to psychology are not hard to find in any historical era, and many people seem to have difficulty seeing the inherent weaknesses in pseudoscientific doctrines. As you develop your skills as a critical thinker by taking this research methods course, however, you should be able to distinguish valid psychological science from that which merely pretends to be.

The Goals of Research in Psychology

Unlike pseudoscience, scientific research in psychology has four interrelated goals. Researchers hope to develop complete descriptions of behaviors, to be able to make predictions about future behavior, and to be able to provide reasonable explanations of behavior. Furthermore, they assume that the knowledge derived from their research will be applied so as to benefit people, either directly or eventually. Below we introduce you to each of these goals: description, prediction, explanation, and application. They will be discussed in more depth in later chapters of the book, and they form the structure of how we report our research to others (see Appendix A).

Describe

To provide a good **description** in psychology is to identify regularly occurring sequences of events, including both stimuli or environmental events and responses or behavioral events. For example, a description of aggressive behavior in some primate species might include a list of the situations in which fighting is most likely to occur (e.g., over food), the types of threat signals that might precede actual combat (e.g., baring teeth), and the form of the fight itself (e.g., attacks directed at non-vital areas like shoulders and haunches). Description also involves classification, as when someone attempts to classify various forms of aggressive behavior (e.g., fighting vs.

predation). Providing a clear, accurate description is an essential first step in any scientific endeavor; without it, predictions cannot be made and explanations are meaningless. Some research in psychology is primarily descriptive in nature. For example, most survey/questionnaire and observational research falls into this category. You will learn more about this research in Chapters 9 and 10.

Predict

To say that behavior follows **laws** is to say that regular and predictable relationships exist for psychological phenomena. The strength of these relationships allows **predictions** to be made with some degree of confidence. After describing numerous primate fights, for example, it might become clear that after two animals fight over food and one wins, the same two animals won't fight again. If they both spot a banana at the same time, the winner of the initial battle might display a threat gesture and the loser of that first fight will probably go away. If that series of events happened often enough, the researchers could make predictions about future encounters between these animals and, more generally, between animals who are winners and losers of fights. One of the primary strengths of research that uses correlation and regression, as you will learn in Chapter 9, is that it is useful for making predictions. A correlation between SAT scores and college GPA enables admissions departments at colleges to use SAT scores to predict success in college (up to a point).

Explain

The third goal of the experimenter is **explanation**. To explain some behavior is to know what caused it to happen. The concept of causality is immensely complex, and its nature has occupied philosophers for centuries. Psychological scientists recognize the tentative nature of explanations for behavior, but they are generally willing to conclude that X is causing Y to occur if they conduct an experiment in which they systematically vary X, control all other factors that could affect the results, and observe that Y occurs with some probability greater than chance and that variations of Y can be predicted from the variations in X. Furthermore, they will have confidence in the causal explanation to the extent that (a) the explanation makes sense with reference to some theory or some already existing sets of laws, and (b) other possible explanations for Y occurring in the presence of X can be ruled out. The process of theory building, and of how empirical research is derived from and affects the development of theory, will be elaborated in Chapter 3. For now, simply be aware that causality is a complicated process involving experimental control, a time sequence with cause preceding effect, a theoretical structure, and the ruling out of alternative explanations. As you will see, starting in Chapter 5, research psychologists believe that, within some limits, causal conclusions can be drawn from a type of research called experimental research.

Apply

This final goal of psychological science, **application**, refers simply to the various ways of applying those principles of behavior learned through research. Psychologists assume that because of the knowledge derived from the research they do, it is possible for people's lives to change for the better. Hence, research on the factors influencing depression enables therapists to help people diagnosed with depression, research on aggression can help parents raise their children more effectively, and so on. Pioneer cognitive psychologist George Miller (1969) concluded his presidential address to the APA stating

> I can imagine nothing we could do that would be more relevant to human welfare, and nothing that could pose a greater challenge to the next generation of psychologists, than to discover how best to give psychology away. (p. 1074)

What Miller meant was that it is crucial for psychological scientists to share their work with the general public for the betterment of society. Researchers today in clinical psychology, for example, sometimes refer to their work as **translational research**, or research that is done for both better understanding of a particular phenomenon as well as for its application to promote physical and psychological well-being. Translational research will be elaborated in Chapter 11. In summary, it is certainly a goal for psychological scientists to follow Miller's lead to "[instill] our scientific results . . . in the public consciousness in a practical and useful form so that what we know can be applied by ordinary people" (p. 1068) or . . . "to give [psychology] away to the people who really need it—and that includes everyone" (p. 1071).

SELF TEST

1.3

1. How did pseudoscientific phrenologists get around the problem of falsification?
2. What is anecdotal evidence and what is the problem with using it as a way to support the truth of some claim?
3. In psychological science, what is a law, and with which goal is it associated?

A Passion for Research in Psychology

Near the end of his long and productive life, the renowned Russian physiologist Ivan Pavlov was asked to write a brief article for a student journal on what it takes to be a great scientist. Pavlov wrote that it took three things. The first was to be systematic in the search for knowledge and the second was to be modest and to always recognize one's basic ignorance. The third thing, he wrote, was "*passion*. Remember that science demands [your] whole life. And even if you could have two lives, they would not be sufficient. Science calls for tremendous effort and great passion. Be passionate in your work and in your search for truth" (quoted in Babkin, 1949, p. 110; italics added). A similar sentiment is evident in the words of cognitive psychologist Elizabeth Loftus. In graduate school, once she found a topic that excited her, the practical aspects of memory, Loftus

> spent every free moment in [the] lab, setting up the experimental design, running subjects, tabulating the data, and analyzing the results. . . . I began to think of myself as a *research psychologist*. Oh, those were *lovely* words—I could design an experiment, set it up, and follow it through. I felt for the first time that I was a scientist, and I knew with ultimate clarity that it was exactly what I wanted to be doing with my life. (Loftus & Ketcham, 1991, p. 6; first italics in the original; second italics added)

Although your goal in life might not be to become a researcher, your education in psychological research and scientific thinking is invaluable, and it might very well give you some moments when you have some insight into the words of Pavlov and Loftus. It can be truly exciting to create a study to answer some question that interests you, and there is nothing like the great feeling of discovery that comes from the results of all your hard work. Perhaps the best reason for doing research in psychology is that it is can be enormously rewarding. Yes, it is challenging, frustrating at times, and there will be long hours in the lab, but few researchers would exchange their careers for another. What could be more satisfying than getting an idea about some aspect of human behavior, putting it to the test of a research study, and having the results come out just as you hoped?

Let us wrap up this opening chapter with brief examples of how two legendary experimental psychologists became devoted to their work and found great satisfaction in it.

Eleanor Gibson (1910–2002)

On June 23, 1992, Eleanor Gibson (Figure 1.4) was awarded the National Medal of Science by President George H. W. Bush. It is the highest honor a president can confer on a scientist. Gibson, then 82, was honored for a lifetime of research in developmental psychology, studying topics ranging from how we learn to read to how depth perception develops. She was perhaps best known to undergraduates for her "visual cliff" studies.

Gibson was the prototype of the devoted researcher who persevered even in the face of major obstacles. In her case the burden was sexism. This she discovered on arrival at Yale University in 1935, eager to work in the lab of Robert Yerkes, well known for his work in both comparative psychology and mental testing. She was astounded by her first interview with him. As she later recalled, "He stood up, walked to the door, held it open, and said, 'I have no women in my laboratory'" (Gibson, 1980, p. 246).

Undaunted, Gibson eventually convinced the great behaviorist Clark Hull she could be a scientist and finished her doctorate with him. Then in the late 1940s, she went to Cornell University with her husband, James Gibson (another famous name, this time in perception research). Eleanor labored there as an unpaid research associate for 16 years before being named professor.[3] It was

George Bush Presidential Library and Museum

FIGURE 1.4
Eleanor Gibson receiving the National Medal of Science by President George H. W. Bush in 1992.

[3] Cornell did not pay her a salary during this time, but she earned stipends via the many successful research grants that she wrote (e.g., from the Rockefeller Foundation, National Science Foundation, U.S. Office of Education).

during this period of uncertain status that she completed her work on perceptual development. Some sense of her excitement about this research is evident from her description of how the visual cliff experiments first came about.

The project evolved out of perceptual development research with rats that she was doing with a Cornell colleague, Richard Walk. They were both curious about depth perception. In the army, Walk had studied training programs for parachute jumpers, and at Cornell's "Behavior Farm," Gibson had observed newborn goats avoid falling from a raised platform. She also had a "long-standing aversion to cliffs, dating from a visit to the Grand Canyon" (Gibson, 1980, p. 258). With a lab assistant, Gibson

> hastily put together a contraption consisting of a sheet of glass held up by rods, with a piece of wallpaper under one side of it and nothing under the other side except the floor many feet below.
>
> A few rats left over from other experiments got the first try. . . . We put a board about three inches wide across the division between the surface with flooring and the unlined glass, and put the rats on the board. Would they descend randomly to either side?
>
> What ensued was better than we had dared expect. All the rats descended on the side with textured paper under the glass. We quickly inserted some paper under the other side and tried them again. This time they went either way. We built some proper apparatus after that, with carefully controlled lighting and so on. . . . *It worked beautifully*. (Gibson, 1980, p. 259; italics added)

Gibson and Walk (1960) went on to test numerous species, including, of course, humans. The visual cliff studies, showing the unwillingness of eight-month-olds to cross the "deep side," even with Mom on the other side, are now familiar to any student of introductory psychology.

B. F. Skinner (1904–1990)

If you ask students to name a famous psychologist other than Freud, many will say "B. F. Skinner" (Figure 1.5), psychology's most famous 20th-century scientist. His work on operant conditioning created an entire subculture within experimental psychology called the *experimental analysis of behavior*. Its philosophy and the methods associated with it will be explored in Chapter 12.

Skinner's autobiography (three-volumes—he wasn't shy) provides a marvelous view of his life and work, and the following quote illustrates his almost childlike fascination with making a new discovery. It is from a period when Skinner had just completed his doctorate at Harvard and was staying on there as a prestigious research fellow. In early 1932, he was studying a number of conditioning phenomena, including extinction. In his words:

> My first extinction curve showed up by accident. A rat was pressing the lever in an experiment on satiation when the pellet dispenser jammed. I was not there at the time, and when I returned *I found a beautiful curve*. The rat had gone on pressing although no pellets were received. . . .
>
> The change was more orderly than the extinction of a salivary reflex in Pavlov's setting, and *I was terribly excited*. It was a Friday afternoon and there was no one in the laboratory who I could tell. All that weekend I crossed streets with particular care and avoided all unnecessary risks to protect my discovery from loss through my accidental death. (Skinner, 1979, p. 95; italics added)

There is a thread that weaves together the work of Pavlov, Loftus, Gibson, and Skinner, and countless other researchers in psychology. Pavlov accurately identified this common feature when he exhorted students to be *passionate* about their work. You can detect this passion if you read

UPI/Bettmann/©Corbis

FIGURE 1.5
B. F. Skinner as an eager young graduate student at Harvard, circa 1930.

carefully the quotes above. In both the Gibson and Skinner quotes, the concept of beauty appears. For Gibson, the first visual cliff experiments "worked *beautifully,*" and Skinner found "a *beautiful* curve." Similarly, when Loftus referred to her self-identity as a research psychologist as "*lovely* words" and knew she had found her life's work, that same intensity of feeling was being expressed.

Throughout the remainder of this book, you will be learning the tools of psychological science and will be reading about the research of other psychologists who are committed scientists in love with their work. Our greatest hope is that by the time you have completed this book and your methods course, you will be hooked on research and want to contribute to the growing collection of knowledge about what makes people behave the way they do.

CHAPTER SUMMARY

Why Take This Course?

The research methods course is at the core of the psychology curriculum. It should be taken by all psychology majors because it provides the foundation for doing research in psychology, serves as a basis for understanding other content courses in psychology, makes one a more critical thinker about research, is essential for admission to graduate studies, and teaches scientific thinking.

Ways of Knowing

Our knowledge of the world around us often derives from our experiences and how we interpret them, our reliance on the authority of others, and our use of reason. These sources of knowledge can be quite valuable, but they can also lead to error. Our experiences can be subject to social cognition biases (e.g., belief perseverance, availability heuristic, and confirmation bias), authorities can be wrong, and while reason and logic are essential for critical thinking, reasonable arguments in the absence of empirical evidence can be unproductive in the search for truth. Research psychologists rely heavily on scientific thinking as a way of knowing and understanding behavior.

Science as a Way of Knowing

Research psychologists assume that human behavior is lawful and predictable and that using scientific methods can lead to the discovery of regularities in behavior. Science relies on observations that are more systematic than those made in everyday life, and produces knowledge that is open to public verification (i.e., it is said to be objective—verifiable by more than a single observer); historically, the emphasis on objectivity led to a shift from using introspection as a method to using methods that measured specific behaviors.

Science also requires conclusions about the causes of behavior to be data-based, but scientists recognize that their data-based conclusions are tentative and could change, depending on the outcomes of future studies. The questions asked by scientific researchers are referred to as empirical questions—they are answerable through the use of recognized scientific methods. Scientists also develop theories that are precise enough to meet the test of falsification. Research psychologists are skeptical optimists—optimistic about discovering important things about behavior, but skeptical about claims made without solid empirical support.

Psychological Science and Pseudoscience

It is important to distinguish legitimate scientific inquiry from pseudoscience. The latter is characterized by a deliberate attempt to associate itself with true science, by relying on anecdotal evidence (e.g., glowing testimonials), by developing theories that are too vague to be adequately tested with scientific methods and fail the test of falsification, and by a tendency to explain complicated phenomena with overly simplistic concepts.

The Goals of Research in Psychology

Research in psychology aims to provide clear and detailed descriptions of behavioral phenomena, to develop laws that enable scientists to predict behavior with some probability greater than chance, and to provide adequate explanations of the causes of behavior. The results of psychological research can also be applied to change behavior directly.

A Passion for Research in Psychology

Psychological scientists tend to be intensely curious about behavior and passionate about their work. As a relatively young discipline, psychology has more questions than answers, so doing research in psychology can be enormously rewarding. The joy of doing research can be seen in the lives and work of famous psychologists such as Eleanor Gibson (the visual cliff studies) and B. F. Skinner (the discovery and promotion of operant conditioning).

CHAPTER REVIEW QUESTIONS

At the end of each chapter you will find a set of short essay questions for review. You should study the chapter thoroughly before attempting to answer them. You might consider working through them with a lab partner or with a study group. There are additional review questions, along with detailed feedback, at the online Study Guide on the Student Companion Site. The review material includes multiple choice, fill in the blanks, and matching items.

1. Explain why it would be a good idea to take a research methods course prior to taking courses in such areas as social, abnormal, developmental, and cognitive psychology.
2. As ways of knowing, what are the shortcomings of (a) authority and (b) what Peirce called the *a priori* method?
3. Explain how various social cognition biases should make us cautious about the old saying that "experience is the best teacher."
4. Using the historical example of introspection, explain how research psychologists use the term objectivity.
5. What is an empirical question? Give an example of an empirical question that would be of interest to someone studying the relationship between religion and health.
6. Distinguish between determinism and discoverability, as a research psychologist would use the terms.
7. Describe the essential attributes of science as a way of knowing.
8. Research psychologists are said to be "skeptical optimists." What does this mean?
9. Pseudosciences are criticized for relying on anecdotal evidence. What kind of evidence is this and why is it a problem?
10. Pseudosciences do what they can to appear scientific; use the graphology example to illustrate this point.
11. Research in psychology is said to have four related goals. Describe each.
12. In order for research psychologists to feel confident that they have found a "cause" for some phenomenon, what conditions have to be met?

APPLICATIONS EXERCISES

In addition to review questions, the end of each chapter will include "applications" exercises. These will be problems and questions that encourage you to think like a research psychologist and to apply what you have learned in a particular chapter. For each chapter, in order to give you some feedback, we will provide you with answers to some of the items (about half) in Appendix B. Your instructor will have a complete set of answers to all the exercises.

Exercise 1.1 Asking Empirical Questions

For each of the following non-empirical questions, think of an empirical question that would be related to the issue raised and lead to a potentially interesting scientific study.

1. Is God dead?
2. What is truth?
3. Are humans naturally good?
4. Are women morally superior to men?
5. What is beauty?
6. What is the meaning of life?

Exercise 1.2 Thinking Critically About an Old Saying

You have probably heard the old saying that "bad things come in threes." Use what you have learned about the various ways of knowing and about pseudoscientific thinking to explain how such a belief might be formed and why it is hard to convince a believer that there are problems with the saying. From what you have learned about scientific thinking, explain what needs to be made clearer in order to examine this "theory" more critically. That is, what needs to be precisely defined to determine if the saying is really true?

Exercise 1.3 Arriving at a Strong Belief

Consider people who have a strong belief in a personal God who, they believe, directs their daily lives. Using the various ways of knowing described in this chapter, explain how such a belief might form and be maintained.

Exercise 1.4 Subliminal Self-help

The basic idea behind the pseudoscientific subliminal self-help industry is that you can change some aspect of your behavior if you let your unconscious process motivational messages ("you can lose weight easily") that are sent to you "subliminally"—below the normal threshold for hearing. The process is said to be simple. You put on a CD that seems to have soothing music or gentle-waves-breaking-on-a-beach sounds and just relax. The subliminal messages will reach your unconscious and bring about some type of cognitive/attitudinal change that will lead directly to a change in behavior. The chief attraction is that you don't seem to have to do any work to lose weight, improve your memory, stop smoking, raise your self-esteem, etc.

Do a simple Google search for "subliminal self-help" or "subliminal CD." You will find dozens of sites. Examine two sites—one promoting subliminal techniques and one that provides a more skeptical analysis of them.

1. Consider each of the main aspects of pseudoscience described in the chapter. How does each apply in this case?
2. Even though we have not begun to discuss research design, you probably have some sense of what an experiment is like. Design a simple study that might be a good test of the claim that subliminal messages can change your life.

Exercise 1.5 Social Cognition and the Psychic Hotline

There are a surprising number of otherwise normal people who consult psychics for advice about how to live their lives. Explain how believing in someone who appears to have psychic ability might result from or be strengthened by:

1. belief perseverance
2. confirmation bias
3. the availability heuristic

Answers to Self Tests

✓1.1

1. Improves your ability to be a critical thinker when assessing claims made about human behavior and mental processes.
2. Authority.
3. When students change answers and happen to get the item wrong (statistically less likely than changing an answer and getting it right), the outcome sticks out in their memory because it is painful (loss of points).

✓1.2

1. Behaviors can be measured and agreement among observers can occur.
2. An empirical question is one that can be answered with data collected from a study using scientific procedures. An example: What percentage of students reading this book take the self-tests?
3. A hypothesis is a research prediction that can be deduced from a theory. An example: Students who have higher GPAs are more likely to take this textbook's self-tests than students who have lower GPAs.

✓1.3

1. Phrenologists sidestepped falsification by using combinations of faculties to explain the apparent anomaly.
2. Anecdotal evidence involves using specific examples to support a general claim (they are also known as testimonials); they are problematic because those using such evidence fail to report instances that do not support the claim.
3. A law is a regularly occurring relationship. It applies to the goal of prediction.