Identify a problem

- Determine an area of interest.
- Review the literature.
- Identify new ideas in your area of interest.
- Develop a research hypothesis.

Develop a research plan

- Define the variables being tested.
- Identify participants or subjects and determine how to sample them.
- Select a research strategy and design.
- Evaluate ethics and obtain institutional approval to conduct research.

Conduct the study

- Execute the research plan and measure or record the data.

Analyze and evaluate the data

- Analyze and evaluate the data as they relate to the research hypothesis.
- Summarize data and research results.

Communicate the results

- Method of communication: oral, written, or in a poster.
- Style of communication: APA guidelines are provided to help prepare style and format.

Generate more new ideas

- Results support your hypothesis—refine or expand on your ideas.
- Results do not support your hypothesis—reformulate a new idea or start over.

After reading this chapter, you should be able to:

1 Define science and the scientific method.

2 Describe six steps for engaging in the scientific method.

3 Describe five nonscientific methods of acquiring knowledge.

4 Identify the four goals of science.

5–6 Distinguish between basic and applied research and between quantitative and qualitative research.

7 Delineate science from pseudoscience.

1

Introduction to Scientific Thinking

Are you curious about the world around you? Do you think that seeing is believing? When something seems too good to be true, are you critical of the claims? If you answered yes to any of these questions, the next step in your quest for knowledge is to learn about the methods used to understand events and behaviors—specifically, the methods used by scientists. Much of what you think you know is based on the methods that scientists use to answer questions.

For example, on a typical morning you may eat breakfast because it is "the most important meal of the day." If you drive to school, you may put away your cell phone because "it is unsafe to use cell phones while driving." At school you may attend an exam review session because "students are twice as likely to do well if they attend the session." In your downtime you may watch commercials or read articles that make sensational claims like "scientifically tested" and "clinically proven." At night you may get your "recommended 8 hours of sleep" so that you have the energy you need to start a new day. All of these decisions and experiences are related in one way or another to the science of human behavior.

This book reveals the scientific process, which will allow you to be a more critical consumer of knowledge, inasmuch as you will be able to critically review the methods that lead to the claims you come across each day. Understanding the various strengths and limitations of using science can empower you to make educated decisions and confidently negotiate the many supposed truths in nature. The idea here is that you do not need to be a scientist to appreciate what you learn in this book. *Science* is all around you—for this reason, being a critical consumer of the information you come across each day is useful and necessary across professions.

1.1 Science as a Method of Knowing

Science is the acquisition of knowledge through observation, evaluation, interpretation, and theoretical explanation.

The **scientific method**, or **research method**, is a set of systematic techniques used to acquire, modify, and integrate knowledge concerning observable and measurable phenomena.

This book is a formal introduction to the scientific method. **Science** is one way of knowing about the world. The word *science* comes from the Latin *scientia*, meaning knowledge. From a broad view, science is any systematic method of acquiring knowledge apart from ignorance. From a stricter view, though, science is specifically the acquisition of knowledge using the **scientific method**, also called the **research method**.

To use the scientific method, we make observations that can be measured. An observation can be direct or indirect. For example, we can directly observe the number of students enrolled in a school from one academic year to another. We can also observe how well a student at a school performs on a test by counting the number of correct answers on the test. However, learning, for example, cannot be directly observed. We cannot "see" learning. Instead, we can indirectly observe learning by administering tests of knowledge before and after instruction or by recording the number of correct responses when applying the knowledge to a new situation. In both cases, we indirectly observe learning by defining how we structured our observations to "see" learning. Likewise, consider many other commonly studied behaviors, such as love, resilience, creativity, and loyalty; all of these behaviors must be defined in terms of how we structured our observations to indirectly observe them. Hence, we can make direct observations or we can make indirect observations by defining how we precisely measure a given behavior.

The scientific method requires the use of systematic techniques, many of which are introduced and discussed in this book. Each method or design comes with a specific set of assumptions and rules that make it *scientific*. Think of this as a game. A game, such as a card game or sport, only makes sense if players follow the rules. The rules, in essence, define the game. The scientific method is very much the same. It is defined by rules that scientists must follow, and this book is largely written to identify those rules for engaging in science. To begin this chapter, we introduce the scientific method and then introduce other nonscientific ways of knowing to distinguish them from the scientific method.

Science is one way of knowing about the world by making use of the scientific method to acquire knowledge.

Learning Check 1 ✓

1. Define the scientific method.
2. Engaging in the scientific method is like a game. Explain.

Answers:

1. The scientific method is a set of systematic techniques used to acquire, modify, and integrate knowledge concerning observable and measurable phenomena; 2. Science is defined by rules that all scientists must follow in the same way that all players must follow rules defined for a game or sport.

1.2 The Scientific Method

To engage in the scientific method, we need to organize the process we use to acquire knowledge. This section provides an overview of this process. The remainder of this book elaborates on the details of this process. The scientific method is composed of six general steps, which are shown in Figure 1.1. The steps are the following:

Identify a problem

Develop a research plan

Conduct the study

Analyze and evaluate the data

Communicate the results

Generate more new ideas

Step 1: Identify a Problem

The research process begins when you identify the problem to be investigated, or a problem that can be resolved in some way by making observations. For example, prior work has shown a surprising relationship that the more that young adults use alcohol, the more they engage in exercise behavior (French, Popovici, & Maclean, 2009; Leasure, Neighbors, Henderson, & Young, 2015). From this prior work, Abrantes, Scalco, O'Donnell, Minami, and Read (2017) evaluated possible reasons why this relationship exists among college students. For example, Abrantes et al. tested whether students who drink more also exercise more to compensate for the calories consumed from drinking alcohol. They investigated this problem by observing students and recording their exercise and drinking patterns and their reasons for alcohol use.

In Step 1, we determine what to observe in a way that will allow us to answer questions about the problem we are investigating. In the behavioral sciences, we often investigate problems related to human behavior (e.g., drug abuse; diet and health factors; social, moral, political views), animal behavior (e.g., mating, predation, conditioning, foraging), or processes and mechanisms of behavior (e.g., cognition, learning and memory, consciousness, perceptions). Step 1 is discussed in greater detail in Chapter 2.

(1) Determine an Area of Interest.

The scientific process can take anywhere from a few days to a few years to complete, so it is important to select a topic of research that interests you. Certainly, you can identify one or more human behaviors that interest you.

(2) Review the Literature.

The literature refers to the full database of scientific articles, most of which are now accessible using online search engines. Reviewing the scientific literature is important because it allows you to identify what is known and what can still be learned about the behavior of interest to you. It will be difficult to identify a problem without first reviewing the literature.

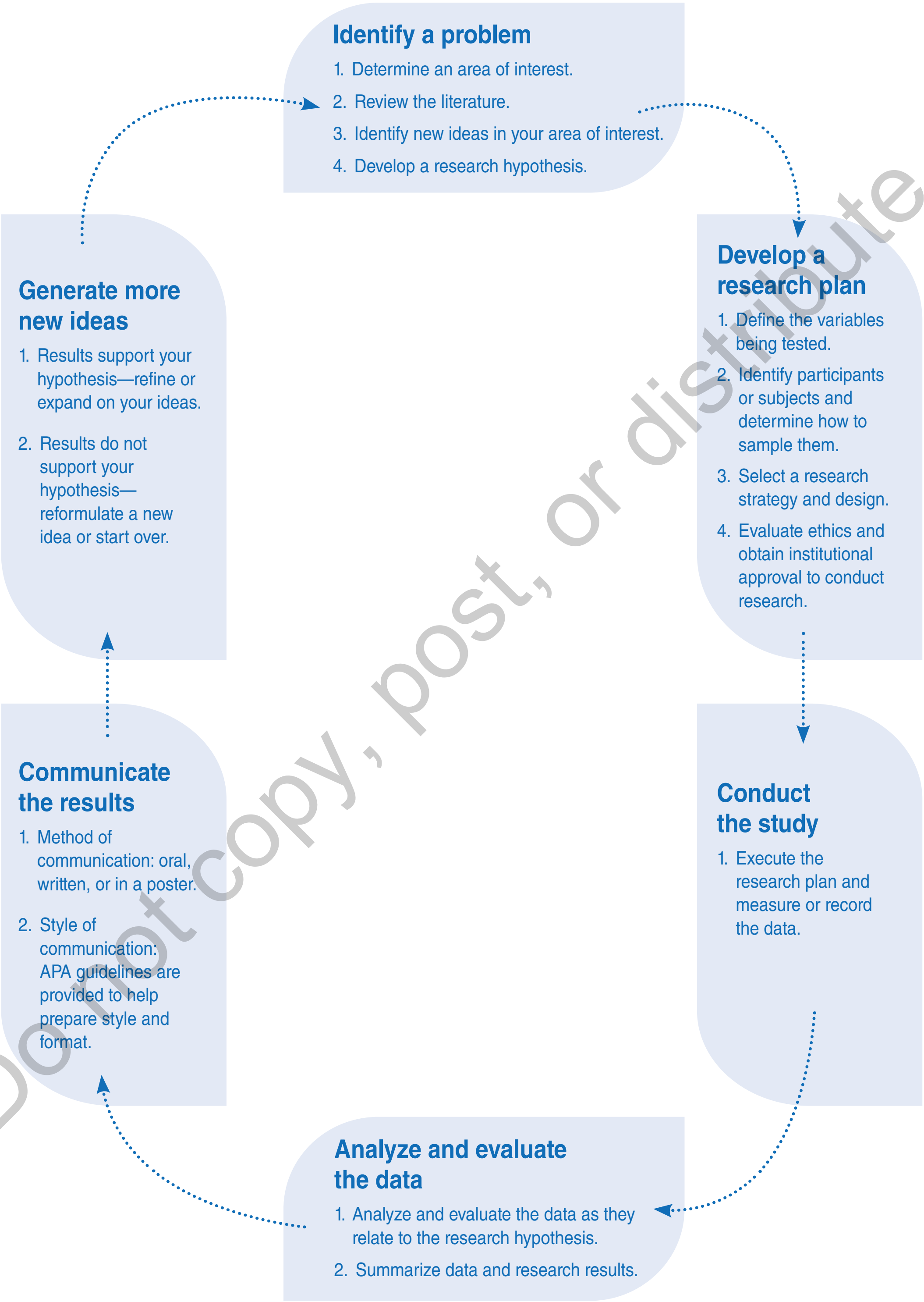
(3) Identify New Ideas in Your Area of Interest.

Reviewing the literature allows you to identify new ideas that can be tested using the scientific method. The new ideas can then be restated as predictions or expectations based on what is known. For example, below are two outcomes identified in a literature review. From these outcomes we then identify a new (or *novel*) idea that is given as a statement of prediction, called a **research hypothesis**:

A **research hypothesis** or **hypothesis** is a specific, testable claim or prediction about what you expect to observe given a set of circumstances.

Scientific Outcome 1: Toy premiums linked to food purchases, such as free toys or collectables, enhance food purchases among children (Jenkin, Madhvani, Signal, & Bowers, 2014).

FIGURE 1.1 ● The Six Steps of the Scientific Method



Scientific Outcome 2: Offering "meal plus free toy" deals to children is associated with a greater frequency of eating fast foods (Emond, Bernhardt, Gilbert-Diamond, Li, & Sargent, 2016).

Research hypothesis: Offering "meal plus free toy" deals for healthier meal options to young children will increase the percentage of children choosing healthier meals.

(4) Develop a Research Hypothesis.

The research hypothesis is a specific, testable claim or prediction about what you expect to observe given a set of circumstances. We identified the research hypothesis that offering "meal plus free toy" deals for healthier meal options to young children will increase the percentage of children choosing healthier meals. This hypothesis is similar to one tested by Dixon, Niven, Scully, and Wakefield (2017), which we will revisit at the end of this section. Note that the research hypothesis we stated is derived from findings in the previous literature. It is important, particularly in science, to build upon (not simply repeat) previous knowledge. Reviewing the literature allows us to identify what we know and build upon that to state research hypotheses that can generate new knowledge.

Step 2: Develop a Research Plan

Once a research hypothesis is stated, we need a plan to test that hypothesis. The development of a *research plan*, or a strategy for testing a research hypothesis, is needed to be able to complete Steps 3 and 4 of the scientific process. The chapters in Sections II, III, and IV of this book discuss Steps 2 to 4 in greater detail. Here, we develop a research plan so that we can determine whether our hypothesis is likely to be correct or incorrect.

(1) Define the Variables Being Tested.

A **variable**, or any value that can change or vary across observations, is typically measured as a number in science. The initial task in developing a research plan is to define or *operationalize* each variable stated in a research hypothesis in terms of how each variable is measured. The resulting definition is called an **operational definition**. For example, we can define the variable identified in the research hypothesis we developed: Offering "meal plus free toy" deals for healthier meal options to young children will increase the percentage of children choosing healthier meals.

A **variable** is any value or characteristic that can change or vary from one person to another or from one situation to another.

An **operational definition** is a description of some observable event in terms of the specific process or manner by which it was observed or measured.

In our research hypothesis, we state that the percentage of choices for a healthier meal option will increase if a "meal plus toy" deal is offered. The term *choice*, however, is a decision made when given two or more options. We need to measure this phenomenon in such a way that it is numeric and others could also observe or measure choice in the same way. How we measure *choice* will be the operational definition we use. For our prediction, we have operationalized choice as a percentage: the *percentage* of children choosing a healthier food option with versus without offering a "meal plus toy" deal.

We could define or operationalize *choice* in other ways, such as a count (i.e., the number of healthier food options chosen). However, in our study, we define this as a percentage (of children choosing a healthier food option). We typically state one operational definition for a variable. In our example, then, we define *choice* as a percentage. The critical part of stating operational definitions is to disclose *how* exactly we objectively measured a behavior numerically, such that another researcher could replicate our measurements. The operational definition we use can often influence the type of study we conduct in Step 3.

To make a testable claim, or hypothesis, it is appropriate to then develop a plan to test that claim.

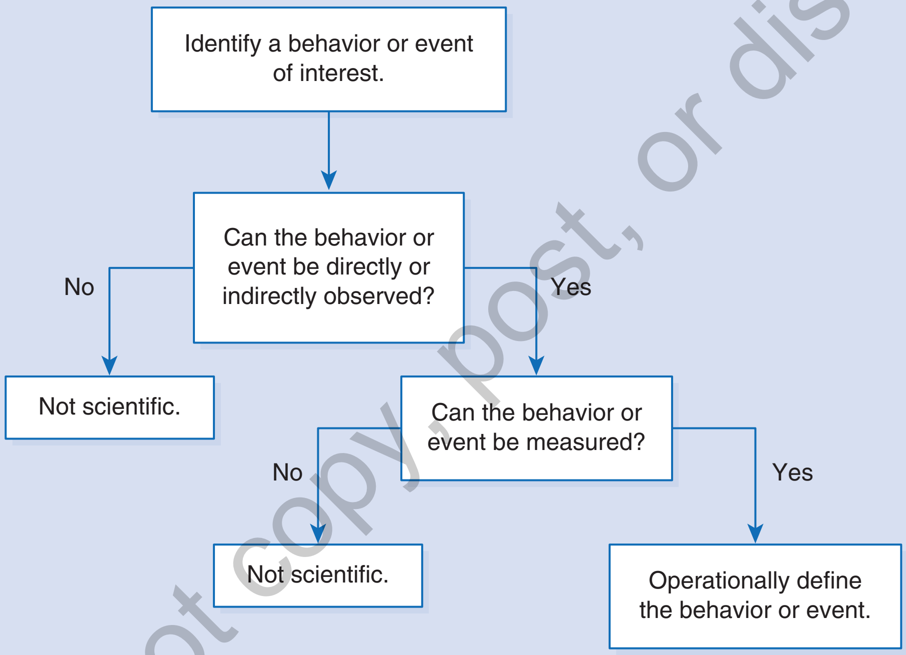
To operationally define a variable, you define it in terms of how you will measure it.

MAKING SENSE—OBSERVATION AS A CRITERION FOR "SCIENTIFIC"

In science, only observable behaviors and events can be tested using the scientific method. Figure 1.2 shows the steps to determine whether a phenomenon can be tested using the scientific method. Notice in the figure that we must be able to observe and measure behaviors and events. Behaviors and events of interest (such as *choice* for a meal) must be observable because we must make observations to conduct the study (Step 3). Behaviors and events must be measurable because we must analyze the observations we make in a study (Step 4)—and to analyze observations, we must have defined the specific way in which we measured those observations.

The scientific method provides a systematic way to test the claims of researchers by limiting science to only phenomena that can be observed and measured. In this way, we can ensure that the behaviors and events we study truly exist and can be observed or measured by others in the same way we observed them by defining our observations operationally.

FIGURE 1.2 ● A Decision Tree for Identifying Scientific Variables



A behavior or event must be observable and measurable to be tested using the scientific method.

(2) Identify Participants or Subjects and Determine How to Sample Them.

A **population** is a set of *all* individuals, items, or data of interest about which scientists will generalize.

Next, we need to consider the population of interest, which is the group that is the subject of our hypothesis. A **population** can be any group of interest. In our research hypothesis, we identify young children. We should define further what *young children* refers to here. In our example, let us define the age range as preteen between the ages of 5 and 12 years (school-aged), which is the typical age of children observed in such studies. The population of interest to us, then, is school-aged children between the ages of 5 and 12 years.

Of course, we cannot readily observe every 5- to 12-year-old child. For this reason, we need to identify a sample of 5- to 12-year-old children whom we will actually observe or have access to study in our study. A **sample** is a subset or portion of individuals selected from the larger group of interest. Observing samples instead of entire populations is more realistic and more economical—it generally requires less time, less money, and fewer resources than observing an entire population. Concomitantly, most scientific research is conducted with samples and not populations. There are many strategies used to appropriately select samples, as is introduced in Chapter 5.

A **sample** is a set of *selected* individuals, items, or data taken from a population of interest.

(3) Select a Research Strategy and Design.

After defining the variables and determining the type of sample for the research study, we need a plan to test the research hypothesis. The plan we use will largely depend on how we defined the variable being measured. For our example, let us develop a research plan for our operational definition of *choice*: The percentage of children choosing a healthier food option with versus without offering a "meal plus toy" deal. Figure 1.3 illustrates the research plan using this operational definition. To structure a study to test our hypothesis, we need to compare choices for healthier meals that offer versus do not offer a toy deal.

Using Operational Definition 2, we predict that a higher percentage of children will choose a healthier meal compared to a less healthy meal if the healthier meal includes a toy deal offer. To test this prediction, we set up a two-group design in which we record the number of children choosing a healthier or less healthy meal in one group that offers no toy deal for either meal (Group No Toy Deal) and in another group where the healthier meal option offers a toy deal (Group Healthier Meal Plus Toy Deal). We then compare the percentage of children choosing the healthier meal with versus without the toy deal offer. Selecting an appropriate research strategy and design is important; nearly half of the chapters in this book (Chapters 6 to 12) are devoted to describing this step.

FIGURE 1.3 ● Developing a Research Plan to Test the Hypothesis

Research Plan
(measuring the percentage of choices made)

Young children are shown two meal options: one that does and one that does not offer a toy deal for the healthier meal. The groups, measurements, and prediction for the hypothesis being tested are.

Groups:	*No Toy Deal Group*: Children choose between a healthier and less healthy meal where both meals do not offer a toy deal.	*Healthier Meal Plus Toy Deal Group*: Children choose between a healthier and less healthy meal where only the healthier meal offers a toy deal.
Measurements:	Operational definition for *choice*: The percent of children choosing a healthier food option with versus without offering a "meal plus toy" deal.	
Prediction from research hypothesis:	A higher percentage of children will choose a healthier meal compared to a less healthy meal if the healthier meal offers a "meal plus toy" deal.	

A research plan with two groups using *percentages* as the operational definition for choice. The type of research design we implement influences how the dependent variable will be defined and measured.

(4) Evaluate Ethics and Obtain Institutional Approval to Conduct Research.

While a research design can be used to test a hypothesis, it is always important to make considerations for how you plan to treat participants in a research study. It is not acceptable to use unethical procedures to test a hypothesis. For example, we cannot force children to choose any foods. Hence, participation in a study must be voluntary. Because the ethical treatment of participants can often be difficult to assess, research institutions have created ethics committees to which a researcher submits a proposal that describes how participants will be treated in a study. Upon approval from such a committee, a researcher can then conduct their study. Because ethics is so important to the research process, this topic is covered in the Ethics in Focus sections in subsequent chapters, and it is also specifically described in detail in Chapter 3.

Learning Check 2 ✓

1. A research hypothesis is typically derived from previous literature because it is important, particularly in science, to (not simply repeat) previous knowledge. (Fill in the blank)
2. A researcher studying attention measured the time (in seconds) that students spent working continuously on some task. Longer times indicated longer attention. In this study, what is the variable being measured, and what is the operational definition for the variable?
3. A psychologist wants to study a small population of 40 students in a local private school. If the researcher is interested in selecting the entire population of students for this study, then how many students must the psychologist include?
   - A. None, because it is not possible to study an entire population in this case.
   - B. At least half, because 21 or more students would constitute most of the population.
   - C. All 40 students, because all students constitute the population.

Answers:
1. build upon; 2. Variable measured: Attention, Operational definition: Time (in seconds) spent continuously working on some task; 3. C.

Step 3: Conduct the Study

The goal of Step 3 is to execute a research plan by conducting the study. In Step 2, we developed a plan to conduct a study to test our hypothesis, same as illustrated in Figure 1.3. Thus, in Step 3 we execute the research plan outlined in Figure 1.3. Using this plan, we would select a sample of school-aged children between the ages of 5 and 12 years, assign them to one of two groups where we ask them to make a choice between a healthier and a less healthy meal, and record the choices made in each group to compare differences between the groups. By doing so, we have conducted the study.

Step 4: Analyze and Evaluate the Data

(1) Analyze and Evaluate the Data as They Relate to the Research Hypothesis.

Data (plural) are measurements or observations that are typically numeric. A **datum** (singular) is a single measurement or observation, usually called a **score** or **raw score**.

Data are typically analyzed in numeric units, such as recording the percentage of children in each group choosing the healthier versus the less healthy meal. In Step 4, we analyze the data to specifically determine whether the pattern of data we observed in our study shows support for the prediction made by our research hypothesis. In our research plan, we start by assuming that there is 0 difference between the groups. We conducted the study to record data that can test this assumption. This is similar to a criminal courtroom where we begin by assuming the defendant (the accused individual) is innocent; we then conduct a trial to present evidence that can challenge/test this assumption. To make a test for our research study, we make use of *statistics*, which is introduced throughout this book to provide a more comprehensive understanding of how researchers make decisions using the scientific method.

Evaluating data, typically using statistical analysis, allows researchers to draw conclusions from the data they observe.

(2) Summarize Data and Report the Research Results.

Once the data are evaluated and analyzed, we need to concisely report them. Data are often reported in tables, or graphically as shown in Figure 1.4 later in this chapter. Also, statistical outcomes are reported by specifically using guidelines identified by the American Psychological Association (APA). The exposition of data and the reporting of statistical analyses are specifically described in Chapters 13 and 14 and throughout the book beginning in Chapter 5.

Step 5: Communicate the Results

To share the results of a study, we must decide how to make our work available to others, as identified by the APA.

(1) Method of Communication.

Communicating your work allows other professionals to review your work to learn about what you did, test whether they can replicate or build upon your results or use your study to generate their own new ideas and hypotheses. The most typical ways of sharing the results of a study are orally, in written form, or as a poster.

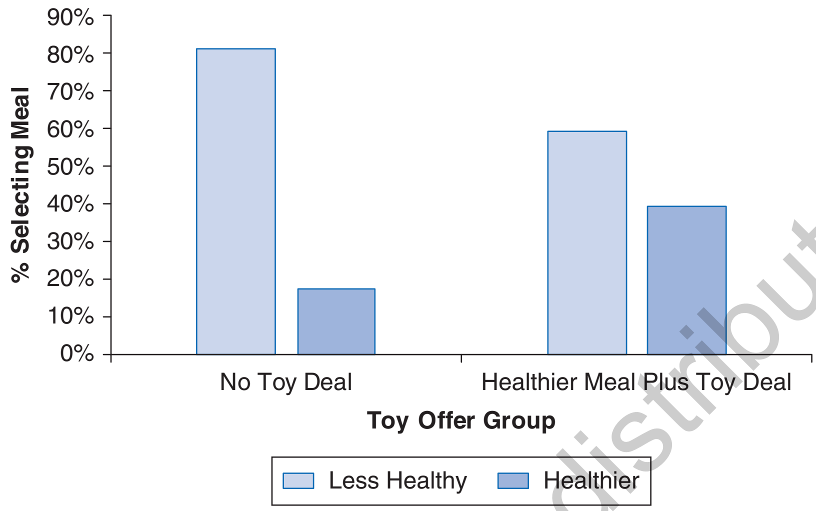
Oral and poster presentations are often given at professional conferences, such as national conferences held by the APA, the Association for Psychological Science (APS), and the Society for Neuroscience. The strongest method for communication, however, is through publication in a peer-reviewed journal. To publish in these journals, researchers describe their studies in a manuscript and have it reviewed by their peers (i.e., other professionals in their field of study). Only after their peers agree that the researchers' study reflects high-quality scientific research can they publish their manuscript in the journal. Chapter 15 provides guidelines for writing manuscripts using APA style, as well guidelines for writing posters and giving talks. Several examples of posters and an APA manuscript that has been published are given in Appendix A.

(2) Style of Communication.

Written research reports often must conform to the style and formatting guidelines provided in the *Publication Manual of the American Psychological Association* (APA; 2010), also called the *Publication Manual*. The *Publication Manual* is a comprehensive guide for using ethics and reducing bias, writing manuscripts and research reports, and understanding the publication process. It is essential that you refer to this manual when choosing a method of communication. After all, most psychologists and many scientists across the behavioral sciences follow these guidelines.

For our research hypothesis, Dixon et al. (2017) also used a similar research plan except their study included more groups for comparison. Two groups were the same as those

FIGURE 1.4 ● A Portion of the Results Reported by Dixon et al. (2017)



Offering a toy deal with a healthier meal increases the percentage of children choosing a healthier meal compared to a condition in which no toy deal was offered. These results are adapted from those reported by Dixon et al. (2017).

in our research plan in Figure 1.3: Group No Toy Deal and Group Healthier Meal Plus Toy Deal. Dixon et al. (2017) then included two additional comparisons: Group Less Healthy Plus Toy Deal, in which the less healthy food offered a toy deal, and Group Both Meals Plus Toy Deal, in which both meals offered a toy deal. The researchers published their results in the peer-reviewed journal *Appetite*. Comparing only the two groups in our research plan, we can see using their results (a portion of which are shown in Figure 1.4) that the data generally show support for our hypothesis—a higher percentage of children chose a healthier meal compared to a less healthy meal when the healthier meal included a toy deal offer.

Step 6: Generate More New Ideas

When your study is complete, you can publish your work and allow other researchers the opportunity to review and evaluate your findings. You have also learned something from your work. If you found support for your research hypothesis, you can use it to refine and build upon existing knowledge. If the results do not support your research hypothesis, then you propose a new idea and begin again.

Steps 1 to 6 of the scientific process are cyclic, not linear, meaning that even when a study answers a question, this usually leads to more questions and more testing. For this reason, Step 6 typically leads back to Step 1, and we begin again. More importantly, it allows other researchers to refute scientific claims and question what we think we know. It allows researchers to ask, “If your claim is correct, then we should also observe this” or “If your claim is correct, then this should not be observed.” A subsequent study would then allow other researchers to determine how confident we can be about what we think we know of that particular behavior or event of interest.

Learning Check 3 ✓

1. A researcher measures the following weights of four animal subjects (in grams): 90, 95, 80, and 100. An individual weight is referred to as a ________, whereas all weights are referred to as ________.
2. State three methods of communication. What style of communication is used in psychology and much of the behavioral sciences?

Answers:

1. Datum, data; 2. Oral, written, and as a poster. APA style is used in psychology and much of the behavioral sciences.

1.3 Other Methods of Knowing

The scientific method is one way of knowing about the world. There are also many other ways of knowing, and each has its advantages and disadvantages. Five other methods of knowing that do not use the scientific process are collectively referred to as nonscientific ways of knowing. Although not an exhaustive list, the five nonscientific ways of knowing introduced in this section are tenacity, intuition, authority, rationalism, and empiricism. Keep in mind that at some level each of these methods can be used with the scientific method.

Tenacity

Tenacity is a method of knowing based largely on habit or superstition; it is a belief that exists simply because it has always been accepted. Advertising companies, for example, use this method by creating catchphrases such as Budweiser's slogan "King of Beers," Nike's slogan "Just Do It," or Geico's much longer slogan "15 minutes could save you 15% or more on car insurance." In each case, tenacity was used to gauge public belief in a company's product or service. A belief in superstitions, such as finding a penny heads up bringing good luck, or a black cat crossing your path being bad luck, also reflects tenacity. Tenacity may also reflect tradition. The 9-month school calendar providing a 3-month summer vacation originated in the late 1800s to meet the needs of communities at the time (mostly due to heat, not farming). While the needs of our society have changed, the school calendar has not. The key disadvantage of using tenacity, however, is that the knowledge acquired can often be inaccurate, partly because tenacity is mostly assumed knowledge. Hence, there is no basis in fact for beliefs using tenacity.

Tenacity is a method of knowing based largely on habit or superstition.

The scientific process is cyclic, not linear; it is open to criticism and review.

Intuition

Intuition is an individual's subjective hunch or feeling that something is correct. Intuition is sometimes used synonymously with instincts. For example, stock traders said to have great instincts may use their intuition to purchase a stock that then increases in value, or gamblers said to have great instincts may use their intuition to place a bet that then wins. Caregivers often use their intuition when they suspect their child is getting into trouble at school, or students may use their intuition to choose a major that best fits their interests.

Intuition is a method of knowing based largely on an individual's hunch or feeling that something is correct.

The disadvantage of using intuition as a sole method of knowing is that there is no definitive basis for the belief. Hence, without acting on the intuition, it is difficult to determine its accuracy.

Intuition also has some value in science in that researchers can use their intuition to some extent when they develop a research hypothesis, particularly when there is little to no information available concerning their area of interest. In science, however, the researchers' intuition is then tested using the scientific method. Keep in mind that we use the scientific method to differentiate between hypotheses that do and do not accurately describe phenomena, regardless of how we initially developed our hypotheses. Hence, it is the scientific method, not intuition, that ultimately determines what we know in science.

Authority

Authority is a method of knowing accepted as fact because it was stated by an expert or respected source in a particular subject area.

Authority is knowledge accepted as fact because it was stated by an expert or respected source in a particular subject area. In a given faith-based practice, it is the Bible, the Koran, the Torah, or another text that is the authority. Preachers, pastors, rabbis, and other religious leaders teach about God using the authority of those texts, and the teachings in those texts are accepted based solely on the authority of those texts. Education agencies such as the National Education Association often lobby for regulations that many educators will trust as benefiting them without reviewing in detail the policies being lobbied for. As another example, the U.S. Food and Drug Administration (FDA) was the second most trusted government agency behind only the Supreme Court around the turn of the 21st century (Hadfield, Howse, & Trebilcock, 1998), and the FDA likewise makes policy decisions that many Americans trust without detailed vetting. The disadvantage of using authority as a sole method of knowing is that, in many cases, there is little effort to challenge this type of knowledge, often leaving authoritative knowledge unchecked.

Like intuition, authority has value in science. Einstein's general theory of relativity, for example, requires an understanding of mathematics shared by perhaps a few hundred scientists. The rest of us simply accept this theory as accurate based on the authority of the few scientists who tell us it is. Likewise, many scientists will selectively submit their research for publication in only the most authoritative journals—those with a reputation for being the most selective and publishing only the highest-quality research compared to other presumably less selective journals. In this way, authority is certainly valued to some extent in the scientific community.

Rationalism

Rationalism is a method of knowing that requires the use of reasoning and logic.

Rationalism is any source of knowledge that requires the use of reasoning or logic. Rationalism is often used to understand human behavior. For example, if a spouse is unfaithful to a partner, the partner may reason that the spouse does not love them; if a student receives a poor grade on a homework assignment, the professor may reason that the student did not put much effort into the assignment. Here, the spouse and the professor rationalized the meaning of a behavior they observed—and in both cases they could be wrong. This is a disadvantage of using rationalism as a sole method of knowing, in that it often leads to erroneous conclusions.

Even some of the most rational ideas can be wrong. For example, it would be completely rational to believe that heavier objects fall at a faster rate than lighter objects. This was, in fact, the rational explanation for falling objects prior to the mid-1500s until Galileo Galilei proposed a theory and showed evidence that refuted this view.

Rationalism certainly has some value in science as well inasmuch as researchers can use rationalism to develop their research hypotheses—in fact, we used reasoning to develop our research hypothesis about food packaging. Still, all research hypotheses are tested using the scientific method, so it is the scientific method that ultimately sorts out the rationally sound from the rationally flawed hypotheses.

Empiricism

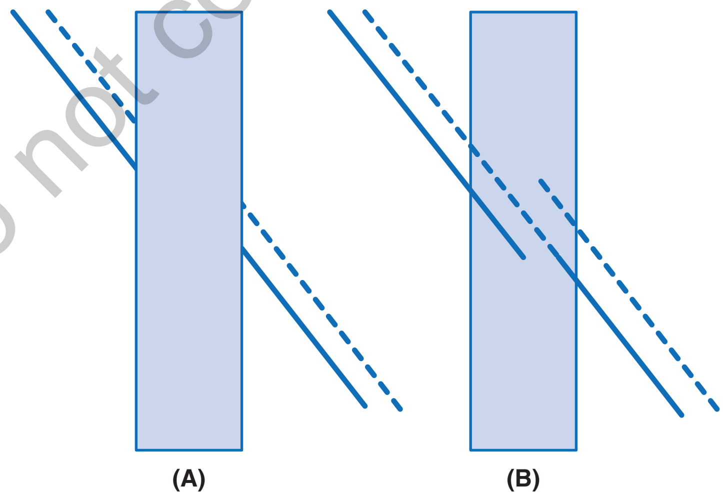
Empiricism is a method of knowing based on one's experiences or observations.

Empiricism is knowledge acquired through observation. This method of knowing reflects the adage "seeing is believing." While making observations is essential when using the scientific method, it can be biased when used apart from the scientific method. In other words, not everyone experiences or observes the world in the same way—from this view, empiricism alone is fundamentally flawed. One way that the scientific method handles this problem is to ensure that all variables observed in a study are *operationally defined*—defined in terms of how the observed variable is measured such that other researchers could observe that variable in the same way. An operational definition has the advantage of being more objective because it states exactly how the variable was observed or measured.

There are many factors that bias our perception of the behaviors and events we observe. The first among them is the fact that human perception can be biased. To illustrate, Figure 1.5 depicts the Poggendorff illusion, named after the physicist who discovered it in a drawing published by German astrophysicist Johann Zöllner in 1860. The rectangles in Parts A and B are the same, except that the rectangle in Part A is not transparent. The lines going through the rectangle in Part A appear to be continuous, but this is an illusion. Viewing them through the transparent rectangle, we observe at once that they are not. There are many instances in which we do not see the world as it really is, many of which we still may not recognize or fully understand.

Human memory is also inherently biased. Many people are prone to forgetting and to inaccurate recollections. Memory is not a bank of recordings to be replayed; rather, it is a collection of representations for the behaviors and events we observe. Memory is an active process, and you are unlikely to accurately recall what you observed unless you make a conscious effort to do so. If you have ever entered a room and forgot why you wanted to

FIGURE 1.5 ● The Poggendorff Illusion



In Part A, both lines appear to be continuous. In Part B, the rectangle is transparent, which shows that the lines are, in fact, not continuous.

go there in the first place, or you forgot someone's name only minutes (often seconds) after being introduced, then you have experienced some of the vagaries of memory. Many factors influence what we attend to and remember, and many of these factors work against our efforts to make accurate observations.

> The nonscientific ways of knowing are ways of acquiring knowledge that are commonly applied but not based in science.

In all, tenacity, intuition, authority, rationalism, and empiricism are called the nonscientific methods of knowing. While some of these methods may be used during the scientific process, they are only used in conjunction with the scientific method. Using the scientific method ultimately ensures that only the most accurate hypotheses emerge from the observations we make.

Learning Check 4 ✓

1. State the five nonscientific methods of knowing.
2. State the method of knowing illustrated in each of these examples.
   A. Your friend tells you that they like fried foods because they saw someone enjoying them at a buffet.
   B. You close the store at exactly midnight because that is when the store always closes.
   C. A teacher states that students do not care about being in school because they are not paying attention in class.
   D. Your caregiver locks up all the alcohol in the house because they have a feeling you may throw a party while they are at work.
   E. You believe that if you do not read your textbook, you will fail your research methods class because your professor said so.

Answers:

1. The five methods of knowing are tenacity, intuition, authority, rationalism, and empiricism; 2. A. empiricism, B. tenacity, C. rationalism, D. intuition, E. authority.

1.4 The Goals of Science

Many people will seek only as much knowledge as they feel will satisfy their curiosity. For instance, people may conclude that they know about love because they have experienced it themselves (empiricism) or listened to stories that others talk about their experiences with love (authority). Yet science is a stricter way of knowing about the world. In science, we do not make observations for the sake of making observations. Instead, we make observations with the ultimate goal to describe, explain, predict, and control the behaviors and events we observe. Each goal is described in this section and listed in Table 1.1.

Describe

To understand the behaviors and events we study, we must describe or define them. Often, these descriptions are in the literature. We can even find descriptions for behaviors and events quite by accident, particularly for those that are not yet described in the literature

TABLE 1.1 ● The Four Goals of Science

Goal	Question Asked to Meet the Goal
Describe	What is the behavior or event?
Explain	What are the causes of the behavior or event?
Predict	Can we anticipate when the behavior or event will occur in the future?
Control	Can we manipulate the conditions necessary to make a behavior or event occur and not occur?

or not fully understood. For example, a young boy named John Garcia had his first taste of licorice when he was 10 years old. Hours later he became ill with the flu. Afterward, he no longer liked the taste of licorice, although he was fully aware that the licorice did not cause his illness. As a scientist, Garcia tried to describe his experience, which eventually led him to conduct a landmark study showing the first scientific evidence that we learn to dislike tastes associated with illness, known as *taste aversion learning* (Garcia, Kimeldorf, & Koelling, 1955). Scientific knowledge begins by describing the behaviors and events we study, even if that description originates from a childhood experience.

Explain

To understand the behaviors and events we study, we must also identify the conditions within which they operate. In other words, to explain behaviors and events, we need to identify their causes. Identifying cause can be a challenging goal in that human behavior is complex and often is caused by many factors in many different contexts. Let us revisit an example from earlier in this chapter: Suppose that we want to explain why young people to exercise. Some obvious factors that can explain why young people exercise are to stay healthy, be more fit, look more attractive, or even to help treat/alleviate symptoms of a disease such as obesity (Privitera, 2016). Less obvious, though, is that the more that young adults use alcohol, the more they engage in exercise behavior (Abrantes et al., 2017; French et al., 2009; Leasure et al., 2015). Imagine how many less obvious factors exist but have not yet been fully explored for many other behaviors of interest to researchers. Explaining behavior (i.e., identifying the causes of behavior) is therefore a cautious goal in science because there are often a multitude of underlying causes to consider to fully explain a given behavior.

Predict

Once we can describe and explain a particular behavior or event, we can use that knowledge to predict when it will occur in the future. Knowing how to predict behavior can be quite useful. For example, if a caregiver wants a child to take a long nap, the caregiver may take the child to the park for an hour before naptime to tire the child out. In this case, the caregiver predicts that greater activity increases sleepiness (Amigo, Peña, Errasti, & Busto, 2016; Lang et al., 2013). However, as with most behaviors, sleep is caused by many factors, so caregivers often find that this strategy does not always work. Predicting behavior, then, can be challenging because to predict when a behavior will occur depends on our ability to isolate the causes of that behavior.

Control

The central, and often most essential, goal for a scientist is control. Control means that we can make a behavior occur and not occur. To establish control, we must be able to describe the behavior, explain the causes, and predict when it will occur and not occur. Hence, control is only possible once the first three goals of science are met.

The ability to control behavior is important because it allows psychologists to implement interventions that can help people improve their quality of life and establish control over aspects of their lives that are problematic. For example, Lowell et al. (2018) reviewed the literature spanning 15 years after the 9/11 attacks in New York City and Washington, D.C. They showed that exposure-based therapies tended to be most effective at reducing symptoms of posttraumatic stress disorder (PTSD) among individuals who were highly exposed to the attacks. Exposure-based therapies generally involve exposing a patient to the source of their stress without the intention of causing any danger. Doing so is believed to help patients *control* or overcome their PTSD. The goal of science to control is often applied in clinical settings, where patients seek to control or overcome symptoms of the disorders they suffer from. Control, then, is a powerful goal of science because it means that researchers are able to establish some control over the behaviors that they study.

> The four goals of science serve to direct scientists toward a comprehensive knowledge of the behaviors and events they observe.

Learning Check 5 ✓

1. State the four goals of science.
2. If researchers can make a behavior occur and not occur, then which goal of science have they met?

Answers:

1. Describe, explain, predict, control; 2. Control.

1.5 Approaches in Acquiring Knowledge

There are many approaches that lead to different levels of understanding of the behaviors and events we study using the scientific method. In this section, we introduce research that is basic or applied and research that is qualitative or quantitative.

Basic and Applied Research

Basic research uses the scientific method to answer questions that address theoretical issues about fundamental processes and underlying mechanisms related to the behaviors and events being studied.

Applied research uses the scientific method to answer questions concerning practical problems with potential practical solutions.

Basic research is an approach where researchers aim to understand the nature of behavior. Basic research is used to answer fundamental questions that address theoretical issues, typically regarding the mechanisms and processes of behavior. Whether there are practical applications for the outcomes in basic research is not as important as whether the research builds upon existing theory. Basic research is used to study many aspects of behavior, such as the influence of biology, cognition, learning, memory, consciousness, and development on behavior.

Applied research, on the other hand, is an approach in which researchers aim to answer questions concerning practical problems that require practical solutions. Topics of interest in applied research include issues related to obesity and health, traffic laws and safety, behavioral disorders, and drug addiction. In the classroom, for example, applied research seeks to answer questions about educational practice that can be generalized across educational settings. Examples of educational applied research include implementing different instructional strategies, character development, caregiver involvement, and classroom management. Researchers who conduct applied research focus on problems with immediate practical implications in order to apply their findings to problems that have the potential for immediate action.

While basic and applied research are very different in terms of the focus of study, we can use what is learned in theory (basic research) and apply it to practical situations (applied research), or we can test how practical solutions to a problem (applied research) fit with the theories we use to explain that problem (basic research). As an example, basic research using brain imaging technologies showed evidence that reward-related areas in the human brain—including areas involved in regulating reward-guided behavior and integrating sensory modalities of smell, taste, and texture—respond preferentially to the sight of high-calorie versus low-calorie foods (Frank et al., 2010; Rolls, 2001). This basic research evaluated theories addressing the neural basis of human eating behavior. Findings from such studies were later utilized as the basis for applied research in clinical settings, showing that this positive response to viewing images of high calorie "comfort foods" enhances positive mood most among those with clinical symptoms of depression, thereby demonstrating a possible intervention to enhance short-term mood without affecting hunger for those with clinical symptoms of depression (Privitera et al., 2018). In this way, the methods used to construct applied research were derived from findings in basic research.

Qualitative and Quantitative Research

Quantitative research uses the scientific method to record observations as numeric data. Most scientific research in the social sciences is quantitative because the data are numeric, allowing for a more objective analysis of the observations made in a study. Researchers, for example, may define *mastery* as the time (in seconds) it takes to complete a presumably difficult task. By defining mastery in seconds (a numeric value), the analysis is more objective—other researchers can readily measure mastery in the same way. Numeric values can also be readily entered into statistical formulas, from which researchers can obtain measurable results. Statistical analysis is not possible without numeric data.

Quantitative research uses the scientific method to record observations as numeric data. Most research conducted in the behavioral sciences is quantitative.

Qualitative research is different from quantitative research in that qualitative research does not include the measurement of numeric data. Instead, observations are made, from which conclusions are drawn. The goal in qualitative research is to describe, interpret, and explain the behaviors or events being studied. As an example, a qualitative researcher studying mastery may interview a small group of participants about their experiences with mastery (e.g., of a skill or a set of skills). Each participant is allowed to respond however they want. From this, the researcher will evaluate how participants described mastery in order to interpret and explain it. Whereas in quantitative research the researcher defines the variable of interest (e.g., mastery) and then makes observations to measure that variable, in qualitative research the participants describe the variable of interest, from which researchers interpret and explain that variable.

Qualitative research uses the scientific method to make nonnumeric observations, from which conclusions are drawn without the use of statistical analysis.

Quantitative and qualitative research can be effectively used to study the same behaviors, so both types of research have value. For example, quantitative research can be used to determine how often and for how long (in minutes, on average) students study for an exam, whereas qualitative research can be used to characterize their study habits in terms of what they study, why they study it, and how they study. Each observation gives the researcher a bigger picture of how to characterize studying among students. In this way, both types of research can be effectively used to gauge a better understanding of the behaviors and events we observe.

1.6 Distinguishing Science From Pseudoscience

Throughout this book, you will be introduced to the scientific process, the general steps for which were elaborated in this chapter. As is evident as you read further, science requires that a set of systematic techniques be followed to acquire knowledge. However, sometimes knowledge can be presented as if it is scientific, yet it is nonscience, often referred to as *pseudoscience*; that being said, all nonscience is not pseudoscience (Hansson, 2015; Mahner, 2007).

Pseudoscience is a set of procedures that are not scientific, and it is part of a system or set of beliefs that try to deceptively create the impression that the knowledge gained represents the "final say" or most reliable knowledge on its subject matter.

The term **pseudoscience** is not to be confused with other terms often inappropriately used as synonyms, which include "unscientific" and "nonscientific." A key feature of pseudoscience is intent to deceive: it is nonscience posing as science (Gardner, 1957; Hansson, 2015). For example, there are ways of knowing that do not at all purport to be based in science, such as those described in Section 1.3 in this chapter. These are not pseudoscience. As another example, an individual may engage in science, but the science itself is incorrect or rather poorly conducted (e.g., the individual misinterprets an observation or runs a careless experiment). Even if the "bad" science is intentional or fraudulent, "bad" science is rarely called pseudoscience. Therefore, to clarify we can adopt two criteria here to define pseudoscience that delineate it as a narrower concept, adapted from Gardner (1957) and Hansson (2015):

1. It is not scientific, and
2. It is part of a system or set of beliefs that try to deceptively create the impression that the knowledge gained represents the "final say" or most reliable knowledge on its subject matter.

As an example to illustrate, consider the following three scenarios:

Scenario 1: A psychologist performs a study and unknowingly analyzes the data incorrectly, then reports erroneous conclusions that are incorrect because of their mistake.

Scenario 2: A psychologist makes a series of impromptu observations, then constructs an explanation for the observations made as if their conclusions were scientific.

Scenario 3: A psychologist reports that they have a personal belief and faith in God and believes that such faith is important.

In the cases above, only Scenario 2 meets the criteria for pseudoscience in that it is not scientific, and the psychologist tries to deceivingly leave the impression that their conclusions have scientific legitimacy when they do not. Scenario 1 is a basic case of "bad" science, and Scenario 3 is simply a nonscientific way of knowing—there was no intent to give the impression that such faith is rooted in science. Being able to delineate science from pseudoscience can be difficult, and the demarcation between science and pseudoscience is often a subject of debate among philosophers and scientists alike. The examples given in this section provide some context for thinking about science versus pseudoscience, which should prove helpful as you read about science in this book.

Pseudoscience is often described as nonscience that looks like science, but it is not.

Learning Check 6 ✓

1. Distinguish between basic and applied research.
2. What is the difference between quantitative and qualitative research?
3. Identify if the following is an example of pseudoscience and explain your answer: A psychologist makes a series of observations while in a waiting room, then constructs an explanation for their observations as if their conclusions were scientific.

Answers:

1. Basic research is used to address theoretical questions regarding the mechanisms and processes of behavior, whereas applied research is used to address questions that can lead to immediate solutions to practical problems; 2. In quantitative research, all variables are measured numerically, whereas qualitative research is purely descriptive (variables are not measured numerically); 3. It is an example of pseudoscience because it is not scientific (i.e., there are no systematic procedures followed) and they try to deceivingly leave the impression that their conclusions are scientific, when they are not.

Chapter Summary

LO 1 Define science and the scientific method.

- **Science** is the acquisition of knowledge through observation, evaluation, interpretation, and theoretical explanation.
- Science is specifically the acquisition of knowledge using the **scientific method**, which requires the use of systematic techniques, each of which comes with a specific set of assumptions and rules that make it *scientific*.

LO 2 Describe six steps for engaging in the scientific method.

- The scientific process consists of six steps:
  - **Step 1:** Identify a problem: Determine an area of interest, review the literature, identify new ideas in your area of interest, and develop a research hypothesis.
  - **Step 2:** Develop a research plan: Define the variables being tested, identify participants or subjects and determine how to sample them, select a research strategy and design, and evaluate ethics and obtain institutional approval to conduct research.
  - **Step 3:** Conduct the study. Execute the research plan and measure or record the data.
  - **Step 4:** Analyze and evaluate the data. Analyze and evaluate the data as they relate to the research hypothesis and summarize data and research results.
  - **Step 5:** Communicate the results. Results can be communicated orally, in written form, or as a poster. The styles of communication follow standards identified by the APA.
  - **Step 6:** Generate more new ideas. Refine or expand the original hypothesis, reformulate a new hypothesis, or start over.

LO 3 Describe five nonscientific methods of acquiring knowledge.

- **Tenacity** is a method of knowing based largely on habit or superstition. A disadvantage of tenacity is that the knowledge acquired is often inaccurate.

- **Intuition** is a method of knowing based largely on an individual's hunch or feeling that something is correct. A disadvantage of intuition is that the only way to determine the accuracy of an intuition is to act on that belief.
- **Authority** is a method of knowing accepted as fact because it was stated by an expert or respected source in a particular subject area. A disadvantage of authority is that there is typically little effort to challenge an authority, leaving authoritative knowledge largely unchecked.
- **Rationalism** is a method of knowing that requires the use of reasoning and logic. A disadvantage of rationalism is that it often leads to erroneous conclusions.
- **Empiricism** is a method of knowing based on one's experiences or observations. Disadvantages of empiricism are that not everyone experiences or observes the world in the same way, perception is often illusory, and memory is inherently biased.

LO 4 Identify the four goals of science.

- The four goals of science are to **describe** or define the variables we observe and measure, **explain** the causes of a behavior or event, **predict** when a behavior or event will occur in the future, and **control** or manipulate conditions in such a way as to make a behavior occur and not occur.

LO 5–6 Distinguish between basic and applied research and between quantitative and qualitative research.

- **Basic research** uses the scientific method to answer questions that address theoretical issues about fundamental processes and underlying mechanisms related to the behaviors and events being studied. **Applied research** uses the scientific method to answer questions concerning practical problems with potential practical solutions.
- **Quantitative research** is most commonly used in the behavioral sciences and uses the scientific method to record observations as numeric data. **Qualitative research** uses the scientific method to make nonnumeric observations, from which conclusions are drawn without the use of statistical analysis.

LO 7 Delineate science from pseudoscience.

- **Pseudoscience** is a set of procedures that are not scientific, and it is part of a system or set of beliefs that try to deceptively create the impression that the knowledge gained represents the "final say" or most reliable knowledge on its subject matter.
- Being able to delineate science from pseudoscience can be difficult, and the demarcation between science and pseudoscience is still a subject of debate among philosophers and scientists alike.

Key Terms

Review Questions

1. Science can be any systematic method of acquiring knowledge apart from ignorance. What method makes science a unique approach to acquire knowledge? Define that method.
2. The scientific method includes a series of assumptions or rules that must be followed. Using the analogy of a game (given in this chapter), explain why this is important.
3. State the six steps for using the scientific method.
4. A researcher reviews the literature and finds that college students tend to perform better in classes that are in their declared major. From this review the researcher hypothesizes that the more interested students are in the material taught, the more they will learn. What method of knowing did the researcher use to develop this hypothesis? Which method of knowing is used to determine whether this hypothesis is likely correct or incorrect?
5. A social psychologist records the number of outbursts in a sample of different classrooms at a local school. In this example, what is the operational definition for classroom interruptions?
6. Identify the sample and the population in this statement: A research methods class has 25 students enrolled, but only 23 students attended class.
7. True or false: Samples can be larger than the population from which they were selected. Explain your answer.
8. A friend asks you what science is. After you answer their question they ask how you knew that, and you reply that it was written in a textbook. What method of knowing did you use to describe science to your friend? Define it.
9. You go out to eat at a restaurant with friends and have the most delicious meal. From this experience, you decide to go to that restaurant again because the food is delicious. What method of knowing did you use to make this decision? Define it.
10. State the four goals of science.
11. Studying the nature of love has proven challenging because it is difficult to operationally define. In this example, which of the four goals of science are researchers having difficulty with?
12. State which of the following is an example of basic research and which is an example of applied research.
    A. A researcher is driven by their curiosity and interest to explore the theoretical relationship between socioeconomic status and political affiliation.
    B. A researcher is interested in exploring the extent to which voters of different socioeconomic status and political affiliation are likely to vote for a particular candidate.
13. Which research, basic or applied, is used to study practical problems in order to have the potential for immediate action?
14. State whether each of the following is an example of quantitative or qualitative research.
    A. A researcher interviews a group of participants and asks them to explain how they feel when they are in love. Each participant is allowed to respond in their own words.
    B. A researcher records the blood pressure of participants during a task meant to induce stress.
    C. A psychologist interested in attention injects rats with a drug that enhances attention and then measures the rate at which the rat presses a lever.
    D. A witness to a crime describes the suspect to police.
15. Is the following an example of pseudoscience? Explain.

    A researcher enters a home and uses a device that shows that some areas of the house have higher electromagnetic fields (EMFs) than others. They conclude that these EMF readings show scientific proof that ghosts or spirits are present in the rooms where the EMFs were highest.

Activities

1. Recall that only behaviors and events that can be observed and measured (operationally defined) are considered scientific. Assuming that all of the following variables are both observable and measurable, state at least two operational definitions for each:

   A student's integrity while taking an exam

   A participant's ability to remember some event

   A caregiver's patience

   The effectiveness of a professor's teaching style

   The quality of life among elderly patients

   The level of drug use among teens

   The amount of student texting during class time

   The costs of obtaining a college education

2. We developed the following three hypotheses using Step 1 of the scientific method. Choose one of the ideas given, or use one of your own, and complete Step 2 of the scientific method.

   a. *Scientific Outcome 1:* The typical student obtains a C+ in difficult courses.

      Scientific Outcome 2: The typical student obtains a C+ in relatively easy courses.

      Research hypothesis: Students will do less work in an easy course than in a difficult course.

   b. *Scientific Outcome 1:* The more calories we consume, the more weight we tend to gain.

      Scientific Outcome 2: Today, Americans consume more calories per day, on average, than they did 20 years ago.

      Research hypothesis: Obesity rates in the U.S. are getting worse due to trends of increased caloric consumption.

   c. *Scientific Outcome 1:* Distractions during class interfere with a student's ability to learn the material taught in class.

      Scientific Outcome 2: Many students use social networking sites during class time.

      Research hypothesis: Students who sign on to social networking sites during class time will learn less material than those who do not.

3. Historically there has been great debate concerning the authority of scientific knowledge versus religious knowledge. What methods of knowing are used in science and religion? What are the differences between these methods, if any? What are the similarities, if any?