

chapter one

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 try to get your “recommended eight 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

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**.

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.

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

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 how much someone consumes in a meal by measuring the weight or calories of food consumed. However, hunger, for example, cannot be directly observed. We cannot “see” hunger. Instead, we can indirectly observe hunger by measuring a physiological response (e.g., insulin levels), or maybe by recording the time since the last meal

(e.g., in hours). In both cases, we indirectly observe hunger by defining how we measure hunger. Time in hours, for example, is not hunger, but we can infer that longer periods of time between meals are associated with greater hunger. Hence, we can make direct or indirect observations of behavior by defining how we exactly measure that 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 all scientists 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.

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 will elaborate 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:

- 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, Painter, Wansink, and Hieggelke (2002) found that placing candies in closer proximity to a participant (i.e., within arm's reach) increased the number of candies participants ate. From this study, Privitera and Creary (in press) identified a problem to be investigated. Specifically, they asked if it matters what you put in the bowl. For example, would placing a bowl of fruits or vegetables closer to participants show a similar result? This was the problem to be investigated that could be resolved by observing participants with a bowl of fruits and vegetables placed far versus near them.

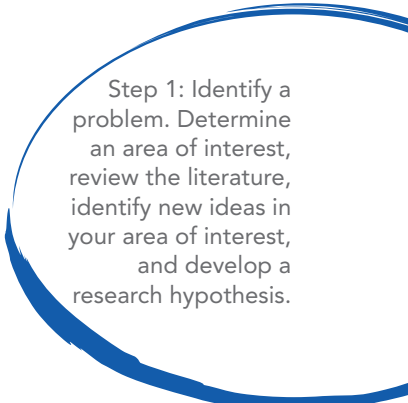
In Step 1, we determine what to observe in a way that will allow us to answer questions about the problem we are investigating. In the behavioral sciences, we often investigate problems related to human behavior (e.g., drug abuse; diet and health factors; social, moral, political views), animal behavior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

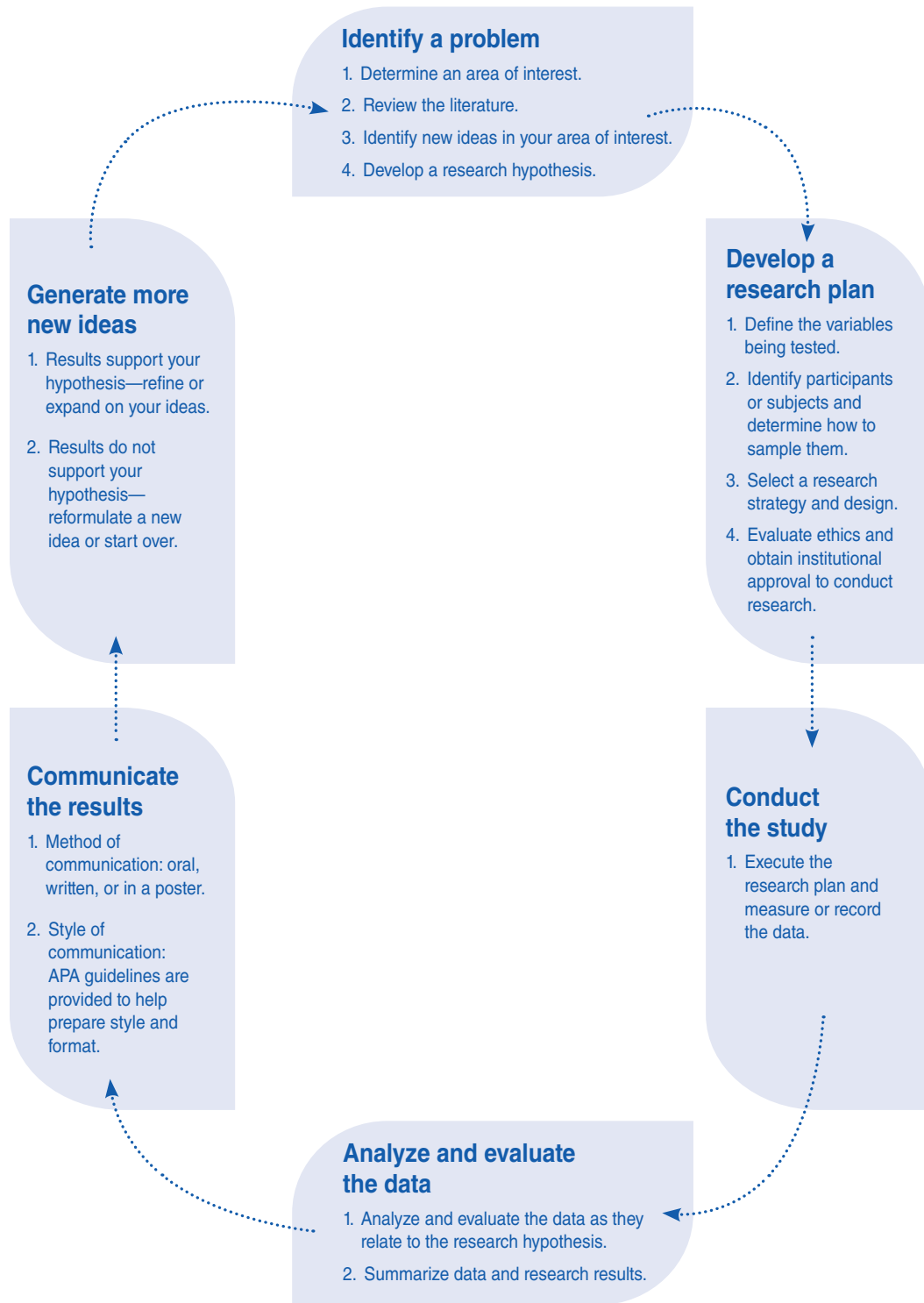
(2) REVIEW THE LITERATURE.

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.



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.

Figure 1.1 The Six Steps of the Scientific Method



(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**:

Scientific Outcome 1: Many children do not like healthy foods.

Scientific Outcome 2: Many children like foods made by McDonald's.

Research hypothesis: Placing healthy foods in McDonald's packaging will increase liking for those foods in children.

(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 placing healthy foods in McDonald's packaging will increase how much children like those foods, similar to a hypothesis tested by Robinson, Borzekowski, Matheson, and Kraemer (2007)—we will revisit this study at the end of this section. We use Steps 2 to 6 of the scientific process to test this hypothesis. Note also that we used the literature review to develop our research hypothesis, which is why we must review the literature before stating 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.

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 will develop a research plan so that we can determine whether our hypothesis is likely to be correct or incorrect.

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.

(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: Placing healthy foods in McDonald's packaging will increase liking for those foods in children.

In our research hypothesis, we state that liking for healthy foods will increase if they are wrapped in McDonald's packaging. The term *liking*,

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.

however, is really a value or emotional judgment of some object. We need a way to measure this phenomenon in such a way that others could also observe or measure liking in the same way. How we choose to measure liking will be the operational definition we use. The following are two ways we could measure or operationalize liking:

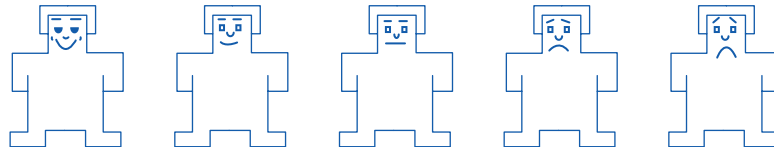
Behaviors and events are operationally defined, meaning that they are defined in terms of how they are measured.

Operational Definition 1: A rating on a picture scale, such as that shown in Figure 1.2. Using this scale, we would infer that higher (or happier) ratings for a food indicate greater liking for that food. (Note that we used a picture scale because children can more easily identify with pictures than numbers.)

Operational Definition 2: A preference choice between two foods. Using a preference choice to measure liking, we would infer that a choice for one food over another indicates greater liking for the chosen food.

Each operational definition clearly identifies how *liking* will be measured—either as a rating on a pictorial scale or as a count (i.e., the number of children choosing one or another food). Both operational definitions make *liking* a suitable variable for scientific study because we have identified how it will be objectively measured. We typically need to choose one operational definition, and our choice can often influence the type of study we conduct in Step 3.

Figure 1.2 A Pictorial Rating Scale Used to Measure Emotion and Liking in Children



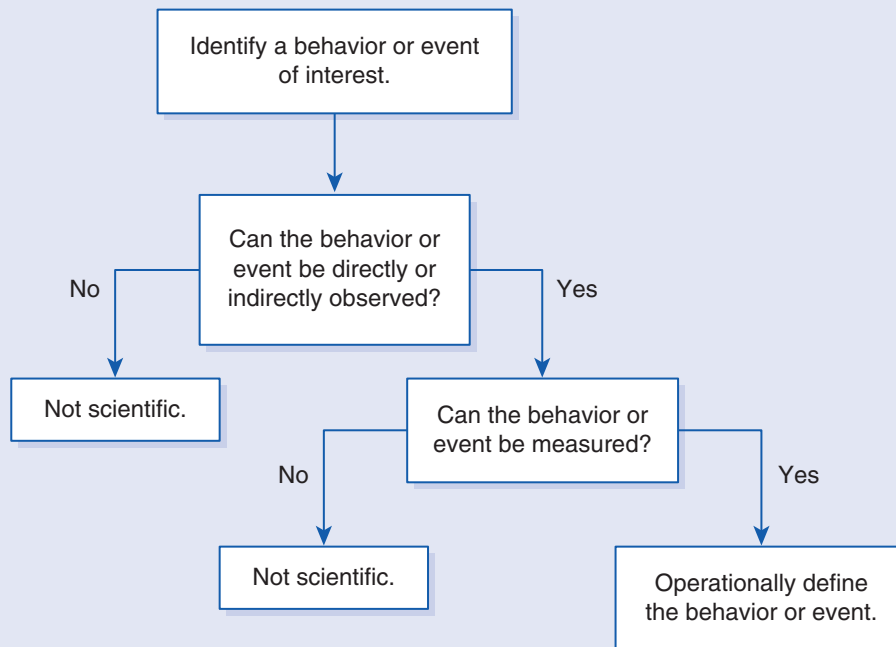
Adapted from Bradley & Lang, 1994.

MAKING SENSE—OBSERVATION AS A CRITERION FOR “SCIENTIFIC”

In science, only observable behaviors and events can be tested using the scientific method. Figure 1.3 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 liking for a food) 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 1.3 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.

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 how children acquire liking for foods (i.e., they like foods more when they are wrapped in McDonald’s packaging). The population of interest to us, then, is children. We need to define this population further so that we can define the exact group of children of interest to us. For example, we could define this group by age range. In this case, we can define the population as children between 3 and 5 years of age.

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

Of course, we cannot readily observe every 3- to 5-year-old child. For this reason, we need to identify a sample of 3- to 5-year-old children that we will actually observe 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. It also requires less time, money, and resources than observing entire populations. Indeed, most scientific research is conducted with samples, and not populations. There are many strategies used for appropriately selecting samples, as introduced in Chapter 5.

A sample is a portion of individuals selected from a larger 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 example, Figure 1.4 illustrates two

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

research plans—one using Operational Definition 1, and a second using Operational Definition 2. Using Operational Definition 1, we predict that children in the McDonald’s Group will give higher ratings for the foods compared with the Plain

Group. To test this prediction, we set up a two-group design to compare differences in ratings between groups.

Using Operational Definition 2, we predict that children will like or prefer foods placed in McDonald’s packaging compared to foods placed in plain packaging. To test this prediction, we set up a one-group design in which we count the number of children choosing one food over the other. Selecting an appropriate research strategy and design is important, so Chapters 6 to 12 in this book are devoted to describing this step.

Figure 1.4 Two Research Plans to Test the Same Hypothesis

<u>Research Plan 1 (Two-group study)</u>		
<i>Groups:</i>	<i>McDonald’s Group:</i> Children consume foods wrapped in McDonald’s packaging.	<i>Plain Group:</i> Children consume foods wrapped in plain packaging.
<i>Measurements:</i>	Operational Definition 1: Ratings of liking for foods consumed. Higher ratings indicate greater liking.	
<i>Prediction from research hypothesis:</i>	Children in the McDonald’s Group will give higher ratings for the foods than those in the Plain Group.	
<u>Research Plan 2 (One-group study)</u>		
<i>Groups:</i>	<i>Choice Group:</i> Children consume the same foods wrapped in either McDonald’s or plain packaging, and then choose which foods they like more.	
<i>Measurements:</i>	Operational Definition 2: The choice for one food is recorded for each child. A choice for one food over another indicates greater liking for the chosen food.	
<i>Prediction from research hypothesis:</i>	More children will choose foods placed in McDonald’s packaging compared to foods placed in plain packaging.	

The type of design used and the predicted result largely depend on how the variable (e.g., liking) is operationally defined.

(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 participants to eat foods they do not want to eat. 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 his or her study. Because ethics is so important to the research process, this topic is covered in each chapter in the Ethics in Focus sections, and also specifically described in detail in Chapter 3.

LEARNING CHECK 2 ✓

1. What three tasks should a researcher perform before stating a research hypothesis?
2. A researcher studying attention measured the time (in seconds) that students spent working continuously on some task. Longer times indicated greater 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. Determine an area of interest, review the literature, and identify new ideas in your area of interest; 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 actually conducting the study. In Step 2, we developed a plan that led to two ways we could conduct a study to test our hypothesis, as illustrated in Figure 1.4. In terms of the research hypothesis we are testing, we execute only one of the plans shown in Figure 1.4. For example, we can choose to execute Research Plan 2. Using this plan, we would select a sample of 3- to 5-year-old children, give the children the same foods wrapped in McDonald's or plain packaging, and record their preference choice for food wrapped in plain or McDonald's packaging. By doing so, we have conducted the study.



Step 3: Conduct the study.

Step 4: Analyze and Evaluate the Data

Step 4: Analyze and evaluate the data.

(1) ANALYZE AND EVALUATE THE DATA AS THEY RELATE TO THE RESEARCH HYPOTHESIS.

Data are typically analyzed in numeric units, such as the counts we analyzed for Research Plan 2 (i.e., number of children choosing one food packaging over the other). In Step 4, we analyze the data to specifically determine if the pattern of data we observed in our study shows support for the research hypothesis. In Research Plan 2, we analyze the data to determine whether more children preferred (i.e., chose) a food wrapped in McDonald's versus plain packaging.

(2) SUMMARIZE DATA AND REPORT THE RESEARCH RESULTS.

Once the data are evaluated and analyzed, we need to concisely report the data. Data are often reported in tables, or graphically as shown in Figure 1.5. Also, statistical

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**.

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 described throughout the book beginning in Chapter 5 and also specifically reviewed in Chapters 13 and 14.

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 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 oral, written, or as a poster.

Oral and poster presentations are often given at professional conferences, such as national conferences held by the APA, the Society for Neuroscience (SFN), and the Association for Psychological Science (APS). 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 their study reflects high-quality scientific research can they publish their manuscript in the journal. Chapter 15 provides guidelines for writing manuscripts using APA style, and 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.

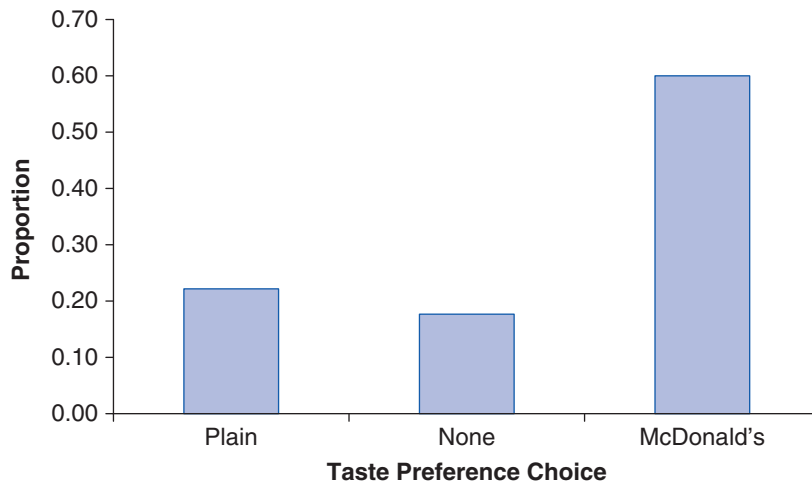
Written research reports must conform to the style and formatting guidelines provided in the *Publication Manual of the American Psychological Association* (APA, 2009), also

Step 5: Communicate the results. Results can be communicated orally, in written form, or as a poster. The styles of communication follow guidelines identified by the APA.

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, we chose Research Plan 2. Robinson et al. (2007) also used a plan similar to Research Plan 2 to determine whether placing healthy foods in McDonald's packaging would increase liking for those foods among children. These researchers published their results in the peer-reviewed journal *Archives of Pediatrics & Adolescent Medicine*. Their results, a portion of which is shown in Figure 1.5, show that our hypothesis is supported by their observations—a larger proportion of children liked foods and drinks given in McDonald's packaging over plain packaging.

Figure 1.5 A Portion of the Results Reported by Robinson et al. (2007)



A larger proportion of children chose foods wrapped in McDonald's brand packaging over the same foods wrapped in plain packaging. The foods and drinks used in this study were a hamburger, chicken nuggets, French fries, milk or apple juice, and carrots. The results are adapted from those reported by Robinson, Borzekowski, Matheson, and Kraemer (2007).

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 expand on 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

Step 6: Generate more new ideas. Refine or expand the original hypothesis, reformulate a new hypothesis, or start over.

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

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

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. 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.

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. Parents often use their intuitions 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. 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 intuitions 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, and not intuitions, that ultimately determines what we know in science.

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

Intuition is a method of knowing based largely on an individual's hunch or feeling that something is correct; there is no definitive basis for an intuition.

Authority

Authority is knowledge accepted as fact because it was stated by an expert or respected source in a particular subject area. In faith-based practices, it is the Bible, the Koran, the Torah, or another text that is the authority in a given faith-based practice. 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. Health agencies such as the Food and Drug Administration (FDA) often create regulations that most Americans will trust without ever questioning them. Indeed, the FDA was the second most trusted government agency behind only the Supreme Court around the turn of the 21st century (Hadfield, Howse, & Trebilcock, 1998). 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

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 a method of knowing accepted as fact because it was stated by an expert or respected source; this type of knowledge is often accepted without question.

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 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 him or her; if a student receives a poor grade on a homework assignment, the professor may reason that he or she did not put much effort into the assignment. Here, the spouse and 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.

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

Rationalism is a method of knowing that requires the use of reasoning and logic, which often leads to erroneous conclusions.

Empiricism

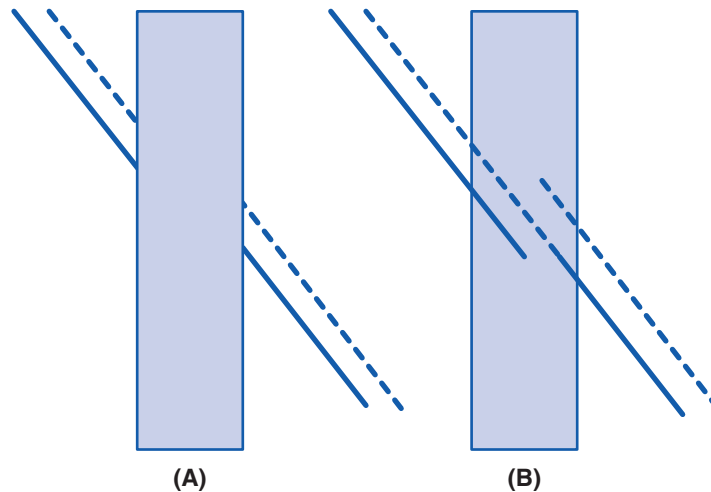
Empiricism is knowledge acquired through observation. This method of knowing reflects the adage “seeing is believing.” While making observations is essential when using the scientific method, it can be biased when used apart from the scientific method. In other words, not everyone experiences or observes 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 1.6 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

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

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.

Figure 1.6 The Poggendorff Illusion



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

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, but rather 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 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.

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.

Empiricism is a method of knowing based on one's experiences or observations. Empiricism is prone to bias because not everyone experiences the world in the same way.

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 he likes fried foods because he saw someone enjoying them at a buffet.
- B. You close up 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 mother locks up all the alcohol in the house because she has a feeling you may throw a party while she is 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

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

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 tell 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 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.

The first goal of science is to describe or define the variables we observe and measure.

Explain

To understand the behaviors and events we study, we must also identify the conditions within which they operate. In other words, we identify what causes a behavior or event to occur. Identifying cause can be a challenging goal in that human behavior is complex

and often caused by many factors in different situations. Suppose, for example, that we want to understand what makes people view someone as being *competent*, which we describe as the ability to successfully master some task or action. Some obvious causes for being viewed as competent are someone's rank or position at work, and education and income level. Less obvious, though, is that an individual will be viewed as more competent if he or she is simply more attractive (see Langlois et al., 2000). Imagine now how many less obvious factors exist but have not yet been considered. Explaining behavior is a cautious goal in science because there are so many variables to consider.

The second goal in science is to explain the conditions or causes for the behaviors or events we study.

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 parent wants a child to take a long nap, the parent may take the child to the park for an hour before naptime to tire the child out. In this case, the parent predicts that greater activity increases sleepiness (for review, see Horne, 1988). However, as with most behaviors, sleep is caused by many factors, so parents 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.

The third goal of science is to predict when a behavior or event will occur.

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 psychologists can use this knowledge to provide interventions that can help people improve their quality of life and establish control over aspects of their lives that are problematic. Psychologists, for example, know a great deal about the causes of many disorders that are well described in the literature. Levitt, Malta, Martin, Davis, and Cloitre (2007) used their knowledge of a variety of factors related to symptoms of depression and post-traumatic stress disorder (PTSD) to implement a behavioral therapy program for 9/11 survivors. Their work found that the behavioral therapy reduced symptoms of depression and PTSD among 9/11 survivors.

The fourth goal of science is to control the conditions necessary to make a behavior occur and not occur.

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?

Hence, the therapy allowed patients to control their disorder by controlling the factors known to cause their disorder. Control, then, is a powerful goal because it means that researchers achieved control over the behaviors that they study.

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 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 and Applied Research

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. 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

Basic research is used to address theoretical questions regarding the mechanisms and processes of behavior; applied research is used to address questions that can lead to immediate solutions to practical problems.

example, basic research using rats to test learning theories in the 1970s showed that adding sugar to a flavored drink increased how much the rats would consume of the flavor subsequently given without the added sugar (Holman, 1975). A similar result was shown with preschool-aged children in an applied research study in which researchers showed that adding sugar to grapefruit juice a few times enhanced liking for the grapefruit juice, even when it was subsequently consumed without the added sugar (Capaldi & Privitera, 2008; Privitera, 2008a). The applied research study in 2008, which was developed from basic research studies over 30 years earlier, proposed immediate solutions that could be applied to strategies for enhancing how much children like consuming low-sugar drinks.

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 *fear* as the time (in seconds) it takes to walk through a presumably scary portion of campus. By defining fear as a number (seconds), the analysis is more objective—other researchers can readily measure fear in the same way. Also, numeric values can be readily entered into statistical formulas, from which researchers can obtain measurable results. Statistical analysis is not possible without numeric data.

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 attraction may interview a small group of participants about their experiences with attraction. Each participant is allowed to respond however he or she wants. From this, the researcher will look at how the participants described attraction in order to interpret and explain what attraction is. Whereas in quantitative research the researcher defines the variable of interest (e.g., attraction) 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.

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 with whom 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.

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

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

Quantitative research limits observations to categories and numeric measurements to obtain statistical results, whereas qualitative research does not include statistical results—instead, researchers draw conclusions that provide a series of interpretations for the observations they make.

LEARNING CHECK 6 ✓

1. Distinguish between basic and applied research.
2. What is the difference between quantitative and qualitative research?

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).

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.

KEY TERMS

science	sample	empiricism
scientific method or research method	data or datum	basic research
research hypothesis or hypothesis	score or raw score	applied research
variable	tenacity	quantitative research
operational definition	intuition	qualitative research
population	authority	
	rationalism	

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 taller men earn greater incomes than shorter men. From this review he hypothesizes that taller men are more intelligent than shorter men. What method of knowing did he 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 her question she asks 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 meeting?
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 her 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 his or her 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. Which research, quantitative or qualitative, uses numeric measurements that are subject to statistical analysis?

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:
 - The morality of politicians
 - A participant's ability to remember some event
 - A mother'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 education a woman has obtained, the larger her salary tends to be.
Scientific Outcome 2: Today, more women earn a PhD in psychology than men.
Research hypothesis: Women in fields of psychology today earn higher salaries than their male colleagues.
 - (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 sign on to 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?

Identify a problem

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

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.

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.

Analyze and evaluate the data

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

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.

After reading this chapter, you should be able to:

- 1 Explain what makes an idea interesting and novel.
- 2 Distinguish between a hypothesis and a theory.
- 3 Distinguish between induction and deduction.
- 4 Describe the process of conducting a literature review.
- 5 Identify four ethical concerns for giving proper credit.
- 6 Describe the "3 Cs" of conducting an effective literature review.
- 7 Distinguish between a confirmational and a disconfirmational strategy.
- 8 Explain the issue of publication bias.