2 Research Methodology

Ask & Answer

ADMIT IT. EVEN THOUGH YOU KNEW it was probably a bad idea at the time, you have used your cell phone to talk or text when it was unwise to do so. Maybe you were in class and could not resist looking at a Snapchat someone just sent you. Or you were walking to class and crossing busy roads while chatting with one of your parents. Or maybe you sent a text message while driving to say you were running late. You are not alone. The risky use of cell phones is common. Various studies have found that 80 percent to 90 percent of college students admit texting while driving on at least one occasion (Harrison, 2011). Unfortunately, texting or phoning while driving can be disastrous.

In 2009, a Boston trolley driver who was texting his girlfriend while on the job rear-ended another trolley, sending 49 people to the hospital and costing the transit system nearly $10 million. In 2007, five recent high school graduates were killed in an accident in upstate New York. The inexperienced driver had been talking on her cell phone minutes before the accident and might have been responding to a text seconds before she crossed the road and struck a semi-trailer head on. In January 2010, 17-year-old Kelsey Raffaele (**FIGURE 2.1**) was driving after school and decided to pass a slower vehicle in front of her. When she saw an oncoming vehicle in the passing lane, she misjudged the distance and crashed, fatally. Kelsey was talking to a friend on her cell phone while driving. Her last words were "Oh [no], I'm going to crash."

Talking on the phone while driving is risky, but texting while driving is even worse, dramatically increasing your chances of having an accident (Dingus,

FIGURE 2.1
Phoning While Driving
Phoning while driving is extremely unsafe. Kelsey Raffaele lost her life because she engaged in this dangerous behavior.

Hanowski, & Klauer, 2011). In laboratories, researchers have examined these practices by using driving simulators (**FIGURE 2.2**). In studies that examined the effects of texting on driving, participants had either less than six months of driving experience (Hosking et al., 2009) or on average five years of driving experience (Drews et al., 2009). The participants "drove" either undistracted or while sending and receiving texts. All participants texting while driving missed more landmarks, made more driving errors, and crashed more than participants who were driving undistracted.

Yet in a 2012 survey by the National Highway Traffic Safety Administration (NHTSA), 25 percent of drivers reported that they believed that texting while driving made no difference on driving performance. Why would people hold this belief? As discussed in Chapter 1, we are often poor judges of our own behavior. We feel overconfident about our abilities and fail to see our own weaknesses. Because we tend to overestimate our own driving abilities—seeing ourselves as "good" drivers even when we are not—we also tend to underestimate the dangers we face, such as through texting while driving. In one study, the participants who most overestimated their ability to drive when distracted were the ones who used the cell phone more while driving in everyday life—and they had worse driving records than the other participants (Schlehofer et al., 2010).

So how can we confirm (and convince people) that texting while driving is dangerous? Indeed, how can we confirm (and convince people of) any claim that is made? This chapter will describe how evidence is gathered and verified in psychology. By understanding these processes, you will learn how to interpret information that is being presented to you. And by understanding how to interpret information, you will become an educated consumer and presenter of information.

Learning Objectives

- Identify the four primary goals of science.
- Describe the scientific method.
- Differentiate among theories, hypotheses, and research.

2.1 How Is the Scientific Method Used in Psychological Research?

This chapter will introduce you to the science and the practice of psychological research methods. You will learn the basics of collecting, analyzing, and interpreting the **data** of psychological science, the measurable outcomes of research studies. In this way, you will come to understand how psychologists study behavior and mental processes. You will also learn how to effectively evaluate claims so you can become a more educated consumer of information.

data
Measurable outcomes of research studies.

Science Has Four Primary Goals

There are four primary goals of science: *description, prediction, control,* and *explanation.* Thus, the goals of psychological science are to describe *what* a phenomenon is, predict *when* it will occur, control *what causes* it to occur, and explain *why* it occurs. For example, consider the observation that texting interferes with driving. To understand how this interference happens, we need to address each of the four goals.

We begin by asking: How many people really text while driving? Answering this question can help us describe the phenomenon of texting while driving—as in noting how prevalent this unsafe behavior is. Now, under what circumstances are people likely to text while driving? Answering this question can help us predict when texting while driving may occur—as in which people tend to engage in the behavior. Next, how can we know that texting is the source of the problematic driving? Answering this question can help us be sure that it is texting and not some other factor that is responsible for the observed effects. Ultimately, knowing the answers to each of these questions leads to the question of why texting interferes with driving. Is it because people use their hands to text, or that they take their eyes off the road, or that it interferes with their mental ability to focus on driving?

Careful scientific study also allows us to understand other aspects of texting and driving, such as why people do it in the first place. Understanding how texting interferes with driving skills and why people continue to text while driving, even when they know it is dangerous, will allow scientists, technology developers, and policymakers to develop strategies to reduce the behavior.

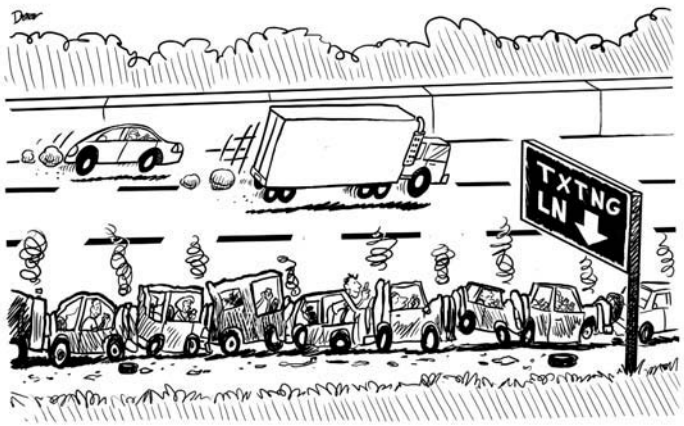
FIGURE 2.2
Driving Simulator
This apparatus enables researchers to study driving skills in the laboratory.

Critical Thinking Means Questioning and Evaluating Information

As you learned in Chapter 1, one important goal of your education is to become a critical thinker. Critical thinking was defined in Chapter 1 as systematically questioning and evaluating information using well-supported evidence. As this definition makes clear, critical thinking is an *ability*—a skill. It is not something you can just memorize and learn, but something you have to practice and develop over time. Most of your courses should provide opportunities for you to practice being a critical thinker. Critical thinking is not just for scientists. It is essential for becoming an educated consumer of information.

The first step in critical thinking is to question information. What kind of information? To develop the skeptical mindset you need for critical thinking, you should question every kind of information. For any claim you see or hear, ask yourself, "What is the evidence in support of that claim?" For example, in the opening vignette of this chapter, we made the claim that texting while driving is dangerous. What kind of evidence did we present in support of this claim? Was the evidence based on direct, unbiased observation, or did it seem to be the result of rumor, hearsay, or intuition? In fact, think of your own beliefs and behavior. Do you believe that texting while driving is dangerous? If you do, what evidence led you to this belief? If you believe that texting while driving is dangerous, do you still text while driving? If so, why do you do it? Do you think the evidence you have seen or heard is not very good? If so, what makes the evidence not very good?

Another aspect of questioning when thinking critically is to ask for the definition of each part of the claim. For example, imagine you hear the claim that using a cell phone while driving is more dangerous than driving while intoxicated (see "Scientific Thinking: Cell Phone Versus Intoxication," on p. 36). Upon hearing this claim, a critical thinker immediately asks for definitions. For example, what do they mean by "using a cell phone"? Do they mean talking or texting? Do they mean a handheld or a hands-free device? And what do they mean by "intoxicated"? Would achieving this state require only a little alcohol or a lot of alcohol? Could the person have used another drug?



Scientific Thinking

Cell Phone Versus Intoxication

HYPOTHESIS: Using a cell phone while driving is more dangerous than driving while intoxicated.

RESEARCH METHOD: Forty adults, ranging in age from 22 to 34, were recruited by a newspaper advertisement to participate in a research study on driving. In the study, the participants were asked to perform two separate tests in a driving simulator: (a) driving while having verbal conversations via a hand-held or hands-free device, and (b) driving after consuming enough alcohol to achieve a .08 percent blood-alcohol content (BAC), a level that is at or above the legal limit for intoxication in most states (see table). To establish their baseline driving performances, all the participants initially drove in the simulator without talking on the phone and without having consumed alcohol.

The tests occurred on two different days. Half of the participants talked on the phone while driving the first day and drank before driving on the second day. The other half drank before driving on the first day and talked on the phone while driving the second day.

RESULTS: Compared to the baseline driving performance, talking on the phone (with either a hand-held or hands-free device) caused a delayed response to objects in the driving scene, including brake lights on the car ahead, and a greater number of rear-end collisions. When they were intoxicated, the participants drove aggressively. They followed other cars more closely and hit the brake pedal much harder than they did in the baseline condition. Talking on a cell phone produced more collisions than driving while intoxicated.

CONCLUSION: Both talking on the cell phone and driving while intoxicated led to impaired driving compared to the baseline condition. Talking on the cell phone, whether holding the phone or not, led to more collisions than when the participants were intoxicated.

SOURCE: Strayer, D. L., Drews, F. A., & Crouch, D. J. (2006). A comparison of the cell phone driver and the drunk driver. *Human Factors: The Journal of the Human Factors and Ergonomics Society, 48,* 381–391.

Blood Alcohol Content and Its Effects

In the United States, blood alcohol content is measured by taking a sample of a person's breath or blood and determining the amount of alcohol in that sample. The result is then converted to a percentage. For example, in many states the legal limit is .08 percent. To reach this level, a person's bloodstream needs to have 8 grams of alcohol for every 100 milliliters of blood.

Different blood alcohol levels produce different physical and mental effects. These effects also vary from person to person. This table shows typical effects.

BAC LEVEL	EFFECTS
.01-.06	Feeling of relaxation Sense of well-being Thought, judgment, and coordination are impaired.
.07-.10	Loss of inhibitions Extroversion Reflexes, depth perception, peripheral vision, and reasoning are impaired.
.11-.20	Emotional swings Sense of sadness or anger Reaction time and speech are impaired.
.21-.29	Stupor Blackouts Motor skills are impaired.
.30-.39	Severe depression Unconsciousness Breathing and heart rate are impaired.
>.40	Breathing and heart rate are impaired. Death is possible.

SOURCE: Based on U.S. Department of Transportation, http://www-nrd.nhtsa.dot.gov/Pubs/811385.pdf

Answering questions of this kind is the second step in critical thinking: the evaluation of information. To answer our questions, we need to go to the source of the claim.

To get to the source of any claim, you need to think about where you first saw or heard the claim. Did you hear the claim on TV or the radio? Did you read about it in a newspaper? Did you see it on the Internet? Next, you need to think about the evidence offered by the source to support the claim.

Here is where the "well-supported evidence" comes in. Does the evidence at the source of the claim take the form of scientific evidence? Or does it take the form of intuition or simply someone in authority making the claim? Did the source retrieve this information from a news wire? Did it come from an interview with a scientist? Was it summarized from a scientific journal?

In science, well-supported evidence typically means research reports based on empirical data that are published in peer-reviewed journals (**FIGURE 2.3**). "Peer review" is a process by which other scientists with similar expertise evaluate and critique research reports before publication. Peer review ensures that published reports describe research studies that are well designed (using appropriate research and analysis methods, considering all factors that could explain the findings), that are conducted in an ethical manner, and that address an important question.

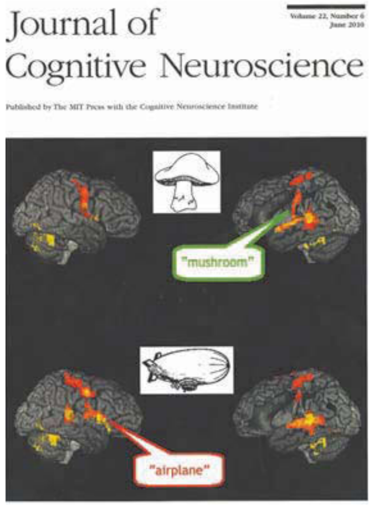


FIGURE 2.3
Peer-Reviewed Journals
Research reports in peer-reviewed journals are the most trustworthy source for scientific evidence.

However, peer review does not mean that flawed studies are never published. Thus, critical thinkers must *always* stay vigilant—always be on the lookout for unreasonable claims and conclusions that may not be valid interpretations of the data. Hone your critical thinking skills by practicing them as often as possible. (At the end of this chapter, the Practice Test includes questions related to designing a scientific study. These questions will both help you practice critical thinking and test the knowledge you have gained from this chapter.)

The Scientific Method Aids Critical Thinking

Critical thinking is determining whether a claim is supported by evidence. Scientific evidence obtained through research is considered the best possible evidence for supporting a claim. **Research** involves the careful collection of data. In conducting research, scientists follow a systematic procedure called the **scientific method.** This procedure begins with the observation of a phenomenon and the question of why that phenomenon occurred.

The scientific method is an interaction among research, theories, and hypotheses (**FIGURE 2.4**). A **theory** is an explanation or model of how a phenomenon works. Consisting of interconnected ideas or concepts, a theory is used to explain prior observations and to make predictions about future events. A **hypothesis** is a specific, testable prediction, narrower than the theory it is based on.

GOOD THEORIES How can we decide whether a theory is good? When we talk about a good theory, we do not mean that it is good because it is supported by research findings. In fact, one key feature of a good theory is that it should be *falsifiable.* That is, it should be possible to test hypotheses generated by the theory that prove the theory is incorrect. Moreover, a good theory produces a wide variety of *testable* hypotheses.

For instance, in the early twentieth century, the developmental psychologist Jean Piaget (1924) proposed a theory of infant and child development (see Chapter 9, "Human Development"). According to Piaget's theory, cognitive development occurs in a fixed series of "stages," from birth to adolescence. From a scientific standpoint, this theory was good because it led to a number of hypotheses. These

research
A scientific process that involves the careful collection of data.

scientific method
A systematic and dynamic procedure of observing and measuring phenomena, used to achieve the goals of description, prediction, control, and explanation; it involves an interaction among research, theories, and hypotheses.

theory
A model of interconnected ideas or concepts that explains what is observed and makes predictions about future events. Theories are based on empirical evidence.

hypothesis
A specific, testable prediction, narrower than the theory it is based on.

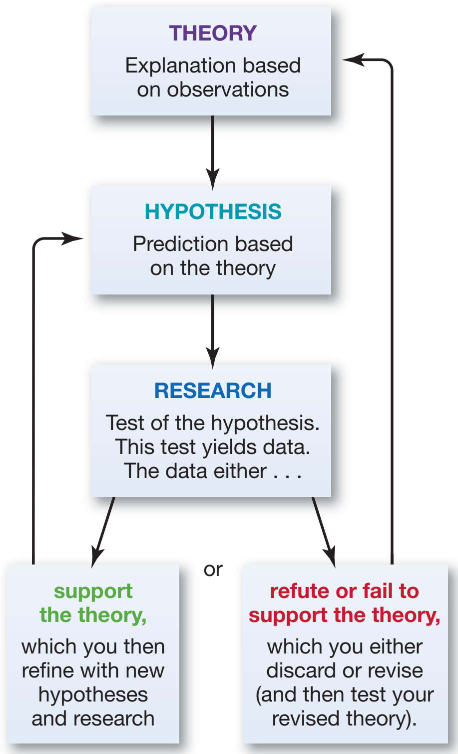


FIGURE 2.4
The Scientific Method
The scientific method reflects a cyclical process: A theory is formulated based on evidence from many observations and refined based on hypothesis tests (scientific studies). From the theory, scientists derive one or more testable hypotheses. Scientists then conduct research to test the hypotheses. Findings from the research might prompt scientists to reevaluate and adjust the theory. A good theory evolves over time, and the result is an increasingly accurate model of some phenomenon.

hypotheses concerned the specific kinds of behaviors that should be observed at each stage of development. In the decades since its proposal, the theory has generated thousands of scientific papers. Our understanding of child development has been enhanced both by studies that supported Piaget's stage theory and by those that failed to support it.

In contrast, Piaget's contemporary Sigmund Freud (1900), in his famous treatise *The Interpretation of Dreams,* outlined the theory that all dreams represent the fulfillment of an unconscious wish. From a scientific perspective, Freud's theory was not good, because it generated few testable hypotheses regarding the actual function of dreams. Since the theory lacked testable hypotheses, researchers were left with no way to evaluate whether the wish fulfillment theory was either reasonable or accurate. After all, unconscious wishes are, by definition, not known to anyone, including the person having the dreams. As a result, not only is there no way to prove that dreams do represent unconscious wishes, but there is no way to prove that dreams do not represent unconscious wishes. Thus, the theory is frequently criticized for not being falsifiable.

Good theories also tend toward simplicity. This idea has historical roots in the writings of the fourteenth-century English philosopher William of Occam. Occam proposed that when two competing theories exist to explain the same phenomenon, the simpler of the two theories is generally preferred. This principle is known as *Occam's Razor* or the *law of parsimony.*

HYPOTHESES NEED TO BE TESTED In order to test hypotheses generated by good theories, we use the scientific method. After an observation has been made and a theory has been formulated, the scientific method follows a series of six steps (**FIGURE 2.5**):

Step 1: Form a Hypothesis

From the opening of this chapter, we have been considering cell phone use while driving. Say that you now propose a theory, derived from news accounts and scientific studies. Your theory is that cell phone use impairs driving ability. How can you determine if this theory is true? You design specific tests—that is, specific research studies—aimed at examining the theory's prediction. These specific, testable research predictions are your hypotheses.

If your theory is true, then the tests should provide evidence that using cell phones while driving causes problems. One of your hypotheses therefore might be: "Using a cell phone while driving will lead to more accidents." To test this hypothesis, you might compare people who use a cell phone frequently while driving with people who do not use a cell phone frequently while driving. You would record how often the people in these groups have accidents. If these results do not differ, this finding raises questions about whether the theory is true.

Step 2: Conduct a Literature Review

Once you form a hypothesis, you want to perform a literature review as soon as possible. A literature review is a review of the scientific literature related to your theory. There are many resources available to assist with literature reviews, including scientific research databases such as PsycINFO and PubMed. You can search these databases by keywords, such as "cell phones and driving" or "cell phones and accidents." The results of your searches will reveal if and how other scientists have been testing your idea. For example, different scientists may have approached this topic at different levels of analysis (see Chapter 1). Their approaches may help guide the direction of your research. For example, you might find a study that compares talking on a cell

Step 1

Form a **Hypothesis**

To test the theory "cell phone use impairs driving ability," you form the hypothesis "Using a cell phone while driving will lead to more accidents."

Step 2

Conduct a **Literature Review**

You search databases by keywords, such as "cell phones and driving" or "cell phones and accidents."

Step 3

Design a **Study**

You test your hypothesis by selecting the most appropriate research method, as determined by your literature review. To test whether cell phone use impairs driving ability, you could conduct a survey, conduct a naturalistic observation, or perform an experiment.

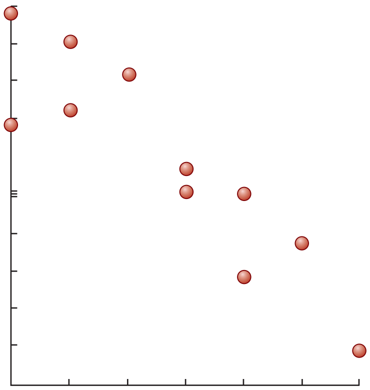
Step 4

Conduct the **Study**

Recruit participants and measure their responses.

Step 5

Analyze the **Data**



Analyze whether the data support or refute the hypothesis. You analyze the data using appropriate statistical techniques and draw conclusions. If the data do not support the hypothesis, you either discard the theory or revise it (and then test the revision).

Step 6

Report the **Results**

Report results and embark on further inquiry. You submit results to research journals and present them at conferences to share them with the scientific community. You continue to refine the theory with further predictions (hypotheses) and tests.

FIGURE 2.5
The Scientific Method in Action
This figure lays out the six steps of the scientific method.

phone while driving with texting while driving. You discover that texting is much more likely to cause accidents. You might then narrow your hypothesis to examine the specific action of texting.

Step 3: Design a Study

Designing a study refers to deciding which research method (and thus, level of analysis) you want to use to test your hypothesis. To test whether texting causes more accidents, you could conduct a survey: Give people a questionnaire that asks how often they text while driving. This method is used widely to gain initial insight into your hypothesis. In large surveys of high school students and college students, more than 40 percent reported texting while driving at least once in the previous 30 days (Olsen, Shults, & Eaton, 2013).

Instead of a survey, you could conduct a naturalistic observation: Watch a particular group of drivers over time and measure how often they text while driving or talk on a cell phone while driving. To establish how cell phone use affects driving, you could more intensively examine drivers by placing devices in their cars to measure aspects such as driving speed and acceleration. Or you could use video cameras to create an objective record of risky driving behaviors, such as running stop signs. One study of 151 drivers using such methods found that cell phone use, especially texting, was a strong predictor of crashes and near-crashes (Klauer et al., 2013).

Alternatively, you could perform an actual experiment, assigning one group of people to texting while driving and a second group of people to no texting, then comparing the number of accidents they have. Obviously, performing a test of this kind on public roads would be dangerous and unethical. Thus, for research like this, scientists use driving simulators that mimic real-world driving conditions. As you will see later when we discuss the different research methods available to test your hypothesis, there are advantages and disadvantages to each of these methods.

Step 4: Conduct the Study

Once you choose your research method, you have to conduct the study: Recruit participants and measure their responses. Many people call this step collecting data or gathering data. If you conduct a survey to see whether people who use cell phones while driving have more accidents, your data will include both the frequency with which people use cell phones while driving and how many accidents they have. All the research methods require you to clarify how you are defining "driving while texting" and "accidents." You must also take care in defining the appropriate size and type of sample of participants. These issues are addressed more completely later in this chapter, under the discussions of operational definitions and sampling.

Step 5: Analyze the Data

The next step is to analyze your data. There are two main ways to analyze data. First, you want to describe the data. What was the average score? How "typical" is that average? Suppose the average driver in your study has five years of driving experience. Does this statement mean five is the most common number of years of driving experience, or that five is the numerical average if you divide the total number of years driven by the total number of participants, or that about half of drivers have this many years of experience?

Second, you will want to know what conclusions you can draw from your data. You need to know whether your results are meaningful or whether they happened by chance. To determine the usefulness of your data, you analyze the data inferentially. That is, you ask whether you found a significant effect. Asking this question enables you to make inferences about your data—to infer whether your findings might be true for the general population. You accomplish data analyses by using descriptive and inferential statistics, which are described more completely later in the chapter.

Step 6: Report the Results

Unreported results have no value, because no one can use any of the information. Instead, scientists make their findings public to benefit society, support the scientific culture, and also permit other scientists to build on their work. Various forums are available for distributing the results of scientific research.

Brief reports can be presented at scientific conferences. The most popular formats for presenting data at conferences are talks and poster sessions. At the latter, people create large posters that display information about their study. During these sessions, researchers stand by their posters and answer questions to those who stop by to read the poster. Conference presentations are especially good for reporting preliminary data or for presenting exciting or cutting-edge results.

Full reports should be published in a peer-reviewed scientific journal (see Figure 2.3). Full reports consist of the background and significance of the research, the full methodology for how the question was studied, the complete results of the descriptive and inferential statistical analyses, and a discussion of what the results mean in relation to the accumulated body of scientific evidence.

Sometimes the results of research are of interest to the general public. People in the media attend scientific conferences and read scientific journals so they can report on exciting findings. Eventually, interesting and important science will reach a general audience.

THE SCIENTIFIC METHOD IS CYCLICAL Once the results of a research study are in, the researchers return to the original theory to evaluate the implications of the data. If the study was conducted competently (i.e., used appropriate methods and data analysis to test the hypothesis), the data either support the theory or suggest that the theory be modified or discarded. Then the process starts all over again. Yes, the same sort of work needs to be performed repeatedly. No single study can provide a definitive answer about any phenomenon. No theory would be discarded on the basis of one set of data. Instead, we have more confidence in scientific findings when research outcomes are replicated.

Replication involves repeating a study and getting the same (or similar) results. When the results from two or more studies are the same, or at least support the same conclusion, confidence increases in the findings. Ideally, researchers not affiliated with those who produced the original finding conduct replication studies. These independent replications provide more powerful support because they rule out the possibility that some feature of the original setting may have contributed to the findings. Within the last few years, there has been a growing emphasis on replication within psychological science.

Good research reflects the cyclical process shown in Figure 2.5. In other words, a theory is continually refined by new hypotheses and tested by new research methods. In addition, often more than one theory may apply to a particular aspect of human behavior so that the theory needs to be refined to become more precise.

For instance, the theory that using a cell phone while driving impairs driving skills might be accurate, but you want to know more. *How* does using a cell phone impair driving? You might develop new theories that take into account the skills needed to be a good driver. You could theorize that using a cell phone impairs driving because it requires taking your hands off the wheel, or perhaps texting requires taking your eyes off the road, or perhaps using a cell phone at all impairs your ability to think about driving. To understand which theory is best, you can design *critical studies* that directly contrast theories to see which theory better explains the data. Replication is another means of strengthening support for some theories and helping weed out weaker theories.

Unexpected Findings Can Be Valuable

Research does not always proceed in a neat and orderly fashion. On the contrary, many significant findings are the result of *serendipity.* In its general sense, serendipity means unexpectedly finding things that are valuable or agreeable. In science, it means unexpectedly discovering something important.

In the late 1950s, the physiologists Torsten Wiesel and David Hubel recorded the activity of nerve cells in cats' brains. Specifically, they were measuring the

replication
Repetition of a research study to confirm the results.

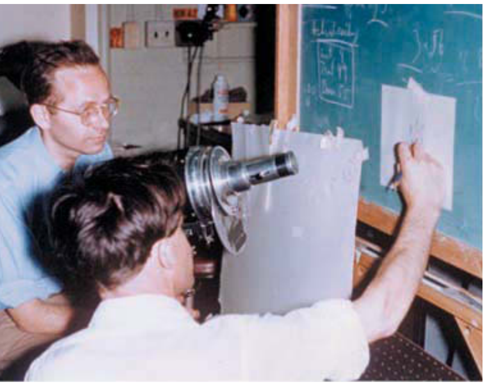


FIGURE 2.6
Wiesel and Hubel's Dot Pattern Experiments
Torsten Wiesel **(foreground)** and David Hubel are shown with their dot projector, 1958.

activity of cells in brain areas associated with vision. Hubel and Wiesel (1959) were studying how information travels from the eye to the brain (a process explored extensively in Chapter 5, "Sensation and Perception"). They had hypothesized that certain cells in the visual portion of the brain would respond when the cats looked at dots. To test that hypothesis, they showed slides of dot patterns to the cats (**FIGURE 2.6**). After much disappointing work that produced no significant activity in the brain cells being observed, the projector suddenly jammed between slides. The cells in question began to fire at an astonishing rate! What had caused this firing? Wiesel and Hubel realized that the jammed slide had produced a visual "edge" on the screen.

Because of this little accident, Wiesel and Hubel discovered that these specific cells do not respond to simple dots. They eventually received a Nobel Prize for the serendipitous finding that certain brain cells respond specifically to lines and edges. Although their discovery is an example of serendipity, these researchers were not just lucky. They did not stumble onto a groundbreaking discovery that led straight to a Nobel Prize. Rather, they followed up on their unexpected finding. Thanks to their critical thinking abilities, they were open to new ideas. After a lifetime of hard work, they understood the implications of the rapid firing of certain brain cells in response to straight lines but not to other types of visual stimuli.

Summing Up

How Is the Scientific Method Used in Psychological Research?

- The four primary goals of science are *description* (describing what a phenomenon is), *prediction* (predicting when a phenomenon might occur), *control* (controlling the conditions under which a phenomenon occurs), and *explanation* (explaining what causes a phenomenon to occur).
- Critical thinking is a skill that helps people become educated consumers of information. Critical thinkers question claims, seek definitions for the parts of the claims, and evaluate the claims by looking for well-supported evidence.
- The scientific method helps psychologists achieve their goals of describing, predicting, controlling, and explaining behavior.
- Scientific inquiry relies on objective methods and empirical evidence to answer testable questions.
- The scientific method is based on the use of theories to generate hypotheses that can be tested by collecting objective data through research. Good theories are falsifiable and will generate several testable hypotheses.
- After a theory has been formulated based on observing a phenomenon, the six steps of the scientific method are forming a hypothesis based on the theory, conducting a literature review to see how people are testing the theory, choosing a research method to test the hypothesis, conducting the research study, analyzing the data, and reporting the results.
- Scientists examine the results to see how well they match the original hypothesis. The theory must be adjusted as new findings confirm or disconfirm the hypothesis.
- Unexpected (serendipitous) discoveries sometimes occur, but only researchers who are prepared to recognize their importance will benefit from them. Although unexpected findings can suggest new theories, these findings must be replicated and elaborated.

Measuring Up

1. How are theories, hypotheses, and research different?
   a. Theories ask questions about possible causes of thoughts, emotions, and behaviors. Hypotheses provide the empirical answers. Research is used to examine whether theories are correct.

b. Theories are broad conceptual frameworks. Hypotheses are derived from theories and are used to design research that will support or fail to support a theory. Research is a test of the hypotheses.
c. Theories are assumed to be true. Hypotheses need to be tested with appropriate experiments. Research is the final step.
d. Theories do not require data for their verification because they are abstract. Hypotheses depend on experimental findings. Research uses human participants to test theories and hypotheses.

2. Why is critical thinking so important?
   a. Critical thinking is important only for scientists who need to do experiments.
   b. Critical thinking enables us to interpret information and evaluate claims.
   c. Critical thinking is necessary for science and math, but it is not important for other disciplines.

ANSWERS: (1) b. Theories are broad conceptual frameworks. Hypotheses are derived from theories and are used to design research that will support or fail to support a theory. Research is a test of the hypotheses. **(2) b.** Critical thinking enables us to interpret information and evaluate claims.

2.2 What Types of Studies Are Used in Psychological Research?

Learning Objectives

- Distinguish between descriptive studies, correlational studies, and experiments.
- List the advantages and disadvantages of different research methods.
- Explain the difference between random sampling and random assignment, and explain when each might be important.

Once a researcher has defined a hypothesis, the next issue to be addressed is the type of research method to be used. There are three main types of research methods: *descriptive, correlational,* and *experimental.* These methods differ in the extent to which the researcher has control over the variables in the study. The amount of control over the variables in turn determines the type of conclusions the researcher can draw from the data.

All research involves variables. A **variable** is something in the world that can vary and that the researcher can manipulate (change), measure (evaluate), or both. In a study of texting and driving ability, some of the variables would be number of texts sent, number of texts received, familiarity with the texting device, how coordinated a person is, and driving ability and cell phone experience.

Scientists try to be as specific and as objective as possible when describing variables. Different terms are used to specify whether a variable is being manipulated or measured. An **independent variable** is the variable that gets manipulated. A **dependent variable** is the variable that gets measured, which is why it is sometimes called the *dependent measure*. Another way to think of the dependent variable is as the outcome that gets measured after a manipulation occurs. That is, the value of the dependent variable *depends* on the changes produced in the independent variable. Since independent variables are specific to the experimental research method, independent and dependent variables will be described more completely in that section of this chapter.

In addition to determining what variables will be studied, researchers must define these variables precisely and in ways that reflect the methods used to assess them. They do so by developing an **operational definition.** Operational definitions are important for research. They *qualify* (describe) and *quantify* (measure) variables so the variables can be understood objectively. The use of operational definitions enables other researchers to know precisely what variables were used, how they were manipulated, and how they were measured. These concrete details make it possible for other researchers to use identical methods in their attempts to replicate the findings.

For example, if you choose to study how driving performance is affected by cell phone use, how will you qualify cell phone use? Do you mean talking, texting, reading

variable
Something in the world that can vary and that a researcher can manipulate (change), measure (evaluate), or both.

independent variable
The variable that gets manipulated in a research study.

dependent variable
The variable that gets measured in a research study.

operational definition
A definition that *qualifies* (describes) and *quantifies* (measures) a variable so the variable can be understood objectively.

content, or some combination of these activities? How will you then quantify cell phone use? Will you count how many times a person uses the cell phone in an hour? Then, how will you quantify and qualify driving performance so you can judge whether it is affected by cell phone use? Will you record the number of accidents, the closeness to cars up ahead, the reaction time to red lights or road hazards, speeding? The operational definitions for your study need to spell out the details of your variables.

FIGURE 2.7
Descriptive Methods
Observational studies—such as this one, using a one-way mirror—are a method that researchers use to describe behavior objectively.

Descriptive Research Consists of Case Studies, Observation, and Self-Report Methods

Descriptive research involves observing behavior to *describe* that behavior objectively and systematically. Descriptive research helps scientists achieve the goals of describing what phenomena are and (sometimes) predicting when or with what other phenomena they may occur. However, by nature, descriptive research cannot achieve the goals of control and explanation (only the true experimental method, described later in this chapter, can do that).

descriptive research
Research methods that involve observing behavior to describe that behavior objectively and systematically.

case study
A descriptive research method that involves the intensive examination of an unusual person or organization.

Descriptive methods are widely used to assess many types of behavior. For example, an observer performing descriptive research might record the types of foods that people eat in cafeterias, measure the time that people spend talking during an average conversation, count the number and types of mating behaviors that penguins engage in during their mating season, or tally the number of times poverty or mental illness is mentioned during a presidential debate (**FIGURE 2.7**). Each of these observations offers important information that can be used to describe current behavior and even predict future behavior. In no case does the investigator control the behavior being observed or explain why any particular behavior occurred.

There are three basic types of descriptive research methods: case studies; observations; and self-report methods and interviews.

CASE STUDIES A **case study** is the intensive examination of an unusual person or organization. By intensive examination, we mean observation, recording, and description. An individual might be selected for intensive study if he or she has a special or unique aspect, such as an exceptional memory, a rare disease, or a specific type of brain damage. An organization might be selected for intensive study because it is doing something very well (such as making a lot of money) or very poorly (such as losing a lot of money). The goal of a case study is to describe the events or experiences that lead up to or result from the exceptional aspect.

One famous case study in psychological science involves a young American man whose freak injury impaired his ability to remember new information (Squire, 1987). N.A. was born in 1938. After a brief stint in college, he joined the Air Force and was stationed in the Azores, where he was trained to be a radar technician. One night, he was assembling a model airplane in his room. His roommate was joking around with a miniature fencing foil, pretending to jab at the back of N.A.'s head. When N.A. turned around suddenly, his roommate accidentally stabbed N.A. through the nose and up into his brain (**FIGURE 2.8**).

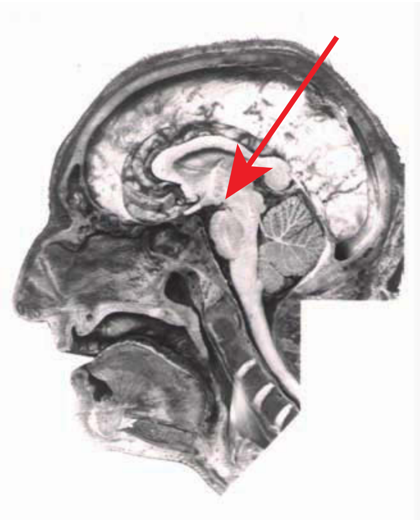


FIGURE 2.8
Case Study Data
In this image of Patient N.A., you can see where the miniature foil penetrated brain regions that had not traditionally been seen as involved in memory. This case study provided new insights into how the brain creates memories.

Although N.A. seemed to recover from his injury in most ways, he developed extreme problems remembering events that happened to him during the day. He could remember events before his accident, and so he was able to live on his own, keeping his house tidy and regularly cutting his lawn. It was new information that he could not remember. He had trouble watching television because he forgot the storylines, and he had difficulty holding conversations because he forgot what others had just said. Subsequent studies of N.A.'s brain using imaging techniques revealed damage to specific regions not traditionally associated with memory difficulties (Squire, Amaral, Zola-Morgan, Kritchevsky, & Press, 1989). The case study of N.A. helped researchers develop new models of the brain mechanisms involved in memory.

However, not everyone who suffers damage to this brain region experiences the same types of problems as N.A. Such differences highlight the major problem with case studies. Because only one person or organization is the focus of a case study, scientists cannot tell from that study if the same thing would happen to other people or organizations who have the same experience(s). The findings from case studies do not necessarily *generalize,* or apply to the general population.

OBSERVATIONAL STUDIES Two main types of observational techniques are used in research: participant observation and naturalistic observation. In **participant observation** (**FIGURE 2.9**), the researcher is involved in the situation. In **naturalistic observation** (**FIGURE 2.10**), the observer is passive, separated from the situation and making no attempt to change or alter ongoing behavior.

CODING These observational techniques involve the systematic assessment and *coding* of overt behavior. Suppose you hear about a person who was texting while walking, stumbled off a curb, and was killed by an oncoming truck. You develop the hypothesis that using a cell phone while walking can cause problems with walking. How do you operationally define "problems with walking"? Once you have defined your terms, you need to code the forms of behavior you will observe. Your coding might involve written subjective assessments (e.g., "He almost got hit by a car when he walked into traffic"). Alternatively, your coding might use predefined categories (e.g., "1. Walked slowly," "2. Walked into traffic," "3. Stumbled"). Perhaps, after recording your data, you would create an index of impaired walking behavior by adding together the frequencies of each coded category. You might then compare the total number of coded behaviors when people were using a cell phone or not. Studies such as these have shown that cell phone use does impair walking ability (Schwebel et al., 2012; Stavrinos, Byington, & Schwedel, 2011). Pedestrian accidents—not all of them involving cell phones—kill more than 500 college-age students per year and injure more than 12,000 (National Highway Traffic Safety Administration, 2012b).

REACTIVITY When conducting observational research, scientists must consider the critical question of whether the observer should be visible. The concern here is that the presence of the observer might alter the behavior being observed. Such an alteration is called **reactivity.** People may feel compelled to make a positive impression on an observer, so they may act differently when they believe they are being observed. For example, drivers who know they were being observed might be less likely to use their cell phones.

Reactivity affected a now-famous series of studies on workplace conditions and productivity. Specifically, the researchers manipulated working conditions and then observed workers' behavior at the Hawthorne Works, a Western Electric manufacturing plant in Cicero, Illinois, between 1924 and 1933 (Olson, Hogan, & Santos, 2006; Roethlisberger & Dickson, 1939). The conditions included different levels of lighting, different pay incentives, and different break schedules. The main dependent variable was how long the workers took to complete certain tasks.

Throughout the studies, the workers knew they were being observed. Because of this awareness, they responded to changes in their working conditions by increasing productivity. The workers did not speed up continuously throughout the various studies. Instead, they worked faster at the start of each new manipulation, regardless of the nature of the manipulation (longer break, shorter break, one of various changes

FIGURE 2.9
Participant Observation
The evolutionary psychologist and human behavioral ecologist Lawrence Sugiyama has conducted fieldwork in Ecuadorian Amazonia among the Shiwiar, Achuar, Shuar, and Zaparo peoples. Here, hunting with a bow and arrow, he is conducting a particularly active form of participant observation.

participant observation
A type of descriptive study in which the researcher is involved in the situation.

naturalistic observation
A type of descriptive study in which the researcher is a passive observer, separated from the situation and making no attempt to change or alter ongoing behavior.

reactivity
The phenomenon that occurs when knowledge that one is being observed alters the behavior being observed.

FIGURE 2.10
Naturalistic Observation
Using naturalistic observation, the primatologist Jane Goodall observes a family of chimpanzees. Animals are more likely to act naturally in their native habitats than in captivity.

Scientific Thinking

The Hawthorne Effect

HYPOTHESIS: Being observed can lead participants to change their behavior.

RESEARCH METHOD (OBSERVATIONAL):

1 During studies of the effects of workplace conditions, the researchers manipulated several independent variables, such as the levels of lighting, pay incentives, and break schedules.

2 The researchers then measured the dependent variable, the speed at which workers did their jobs.

RESULTS: The workers' productivity increased when they were being observed, regardless of changes to their working conditions.

CONCLUSION: Being observed can lead participants to change their behavior because people often act in particular ways to make positive impressions.

SOURCE: Roethlisberger, F. J., & Dickson, W. J. (1939). *Management and the worker: An account of a research program conducted by the Western Electric Company, Hawthorne Works, Chicago*. Cambridge, MA: Harvard University Press.

to the pay system, and so on). The *Hawthorne effect* refers to changes in behavior that occur when people know that others are observing them (see "Scientific Thinking: The Hawthorne Effect").

How might the Hawthorne effect operate in other studies? Consider a study of the effectiveness of a new reading program in elementary schools. Suppose that the teachers know they have been selected to try out a new program. They also know that their students' reading progress will be reported to the schools' superintendent. It is easy to see how these teachers might teach more enthusiastically or pay more attention to each child's reading progress than would teachers using the old program. One likely outcome is that the students receiving the new program of instruction would show reading gains caused by the teachers' increased attention and not by the new program. Thus, in general, observation should be as unobtrusive as possible.

OBSERVER BIAS In conducting observational research, scientists must guard against **observer bias.** This flaw consists of systematic errors in observation that occur because of an observer's expectations.

Observer bias can especially be a problem if cultural norms favor inhibiting or expressing certain behaviors. For instance, in many societies women are freer to express sadness than men are. If observers are coding men's and women's facial expressions, they may be more likely to rate female expressions as indicating sadness because they believe that men are less likely to show sadness. Men's expressions of sadness might be rated as annoyance or some other emotion. Likewise, in many societies women

observer bias
Systematic errors in observation that occur because of an observer's expectations.

are generally expected to be less assertive than men. Observers therefore might rate women as more assertive when exhibiting the same behavior as men. Cultural norms can affect both the participants' actions and the way observers perceive those actions.

experimenter expectancy effect Actual change in the behavior of the people or nonhuman animals being observed that is due to the expectations of the observer.

EXPERIMENTER EXPECTANCY EFFECT There is evidence that observer expectations can even change the behavior being observed. This phenomenon is known as the **experimenter expectancy effect.**

In a classic study by the social psychologist Robert Rosenthal, college students trained rats to run a maze (Rosenthal & Fode, 1963). Half the students were told their rats were bred to be very good at running mazes. The other half were told their rats were bred to be poor performers. In reality, there were no genetic differences between the groups of rats. Nonetheless, when students believed they were training rats that were bred to be fast maze learners, their rats learned the task more quickly! Thus, these students' expectations altered how they treated their rats. This treatment in turn influenced the speed at which the rats learned. The students were not aware of their biased treatment, but it existed. Perhaps they supplied extra food when the rats reached the goal box at the end of the maze. Or perhaps they gave the rats inadvertent cues as to which way to turn in the maze. They might simply have stroked the rats more often (see "Scientific Thinking: Rosenthal's Study of Experimenter Expectancy Effects").

Scientific Thinking

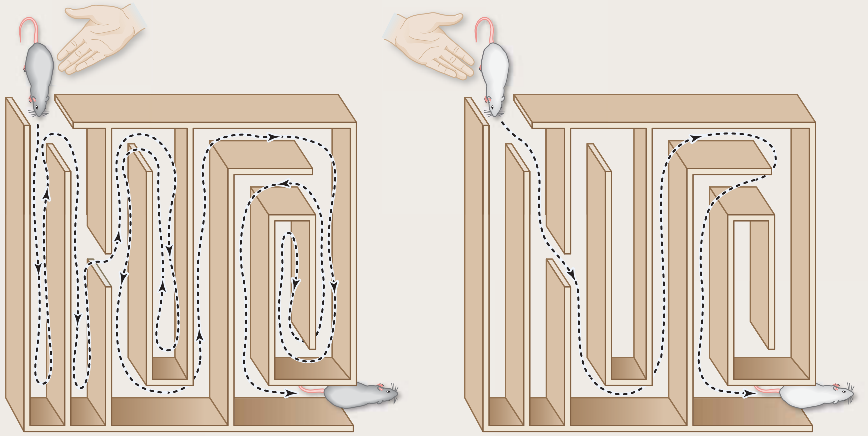
Rosenthal's Study of Experimenter Expectancy Effects

HYPOTHESIS: Research participants' behavior will be affected by experimenters' biases.

RESEARCH METHOD (EXPERIMENT WITH TWO GROUPS):

1. One group of college students were given a group of rats and told to train them to run a maze. These students were told their rats were bred to be very poor at running mazes.

2. A second group of college students were given a group of rats to train that were genetically the same as the first group of rats. These students were told their rats were bred to be very good at running mazes.



RESULTS: The rats trained by the students who believed their rats were bred to be fast maze learners did learn the task more quickly.

CONCLUSION: The results for the two groups of rats differed because the students' expectations caused them to give off subtle cues that changed the rats' behavior.

SOURCE: Rosenthal, R., & Fode, K. L. (1963). The effect of experimenter bias on the performance of the albino rat. *Behavioral Science, 8,* 183–189.

FIGURE 2.11
Self-Report Methods
Self-report methods, such as surveys or questionnaires, can be used to gather data from a large number of people. They are easy to administer, cost-efficient, and a relatively fast way to collect data.

How do researchers protect against experimenter expectancy effects? It is best if the person running the study is *blind* to, or unaware of, the study's hypotheses. For example, the study just described seemed to be about rats' speed in learning to run through a maze. Instead, it was designed to study experimenter expectancy effects. The students believed they were "experimenters" in the study, but they were actually the participants. Their work with the rats was the subject of the study, not the method. Thus, the students were led to expect certain results so that the researchers could determine whether the students' expectations affected the results of the rats' training.

SELF-REPORTS AND INTERVIEWS Ideally, observation is an unobtrusive approach for studying behavior. By contrast, asking people about themselves, their thoughts, their actions, and their feelings is a much more interactive way of collecting data. Methods of posing questions to participants include surveys, interviews, and questionnaires. The type of information sought ranges from demographic facts (e.g., ethnicity, age, religious affiliation) to past behaviors, personal attitudes, beliefs, and so on: "Have you ever used an illegal drug?" "Should people who drink and drive be jailed for a first offense?" "Are you comfortable sending food back to the kitchen in a restaurant when there is a problem?" Questions such as these require people to recall certain events from their lives or reflect on their mental or emotional states.

Self-report methods, such as surveys or questionnaires, can be used to gather data from a large number of people in a short time (**FIGURE 2.11**). Questions can be mailed out to a sample drawn from the population of interest or handed out in appropriate locations. They are easy to administer and cost-efficient.

Interviews, another type of interactive method, can be used successfully with groups that cannot be studied through surveys or questionnaires, such as young children. Interviews are also helpful in gaining a more in-depth view of a respondent's opinions, experiences, and attitudes. Thus, the answers from interviewees sometimes inspire avenues of inquiry that the researchers had not planned.

A problem common to all asking-based methods of data collection is that people often introduce biases into their answers. These biases make it difficult to discern an honest or true response. In particular, people may not reveal personal information that casts them in a negative light. We know we are not supposed to use cell phones while driving, and so we might be reluctant to admit regularly doing so. Researchers therefore have to consider the extent to which their questions produce *socially desirable responding,* or *faking good,* in which the person responds in a way that is most socially acceptable.

FIGURE 2.12
Correlational Studies
There may be a correlation between the extent to which parents are overweight and the extent to which their children are overweight. A correlational study cannot demonstrate the cause of this relationship, which may include biological propensities to gain weight, lack of exercise, and high-fat diets.

Correlational Studies Describe and Predict How Variables Are Related

Correlational studies examine how variables are naturally related in the real world, without any attempt by the researcher to alter them or assign causation between them (**FIGURE 2.12**). Correlational studies are used to describe and predict relationships between variables. They cannot be used to determine the causal relationship between the variables.

Consider an example. On your college application, you likely had to provide a score from a standardized test, such as the SAT or ACT. Colleges require these numbers because standardized test scores have been shown to *correlate* with college success. That is, generally, people who score higher on standardized tests tend to perform better in college. However, does this mean that scoring well on a standardized test will *cause* you to do better in college? Or that doing well in school will *cause* you to do better on standardized tests? Absolutely not. Many people score well on tests but do not perform well in school. Alternatively, many people score poorly on standardized tests but enjoy great success in college.

DIRECTION OF CORRELATION When higher or lower values on one variable predict higher or lower values on a second variable, we say there is a **positive correlation** between them. A positive correlation describes a situation where both variables either increase or decrease together—they "move" in the same direction (**FIGURE 2.13A**). For example, people with higher ACT scores generally have higher college GPAs. People with lower ACT scores generally have lower college GPAs. However, remember that correlation does not equal "cause and effect." Scoring higher or lower on the ACT will *not cause* you to earn a higher or lower GPA.

Remember, too, that *positive* in this case does *not* mean "good." For example, there is a very strong positive correlation between smoking and cancer. There is nothing good about this relationship. The correlation simply describes how the two variables are related: In general, people who smoke experience higher rates of cancer. The more they smoke, the higher their risk of getting cancer.

Some variables are negatively correlated. In a **negative correlation,** the variables move in opposite directions. An increase in one variable predicts a decrease in the other variable. A decrease in one variable predicts an increase in the other variable (**FIGURE 2.13B**). Here, *negative* does not mean "bad."

Consider exercise and weight. In general, the more people exercise, the less they weigh. People who take more vitamins experience fewer colds (Meyer, Meister, & Gaus, 2013).

Some variables are just not related. In this case, we say there is a **zero correlation.** That is, one variable is not predictably related to a second variable (**FIGURE 2.13C**). For example, there is a zero correlation between gender and intelligence. As two groups, men and women are equally smart.

THINKING CRITICALLY ABOUT CORRELATIONS Now that we have described the types of relationships that can exist, let us try to practice our critical thinking skills by interpreting what these relationships mean. Recall that there is generally a negative correlation between exercise and weight. For some people, however, there

self-report methods
Methods of data collection in which people are asked to provide information about themselves, such as in surveys or questionnaires.

correlational studies
A research method that describes and predicts how variables are naturally related in the real world, without any attempt by the researcher to alter them or assign causation between them.

positive correlation
A relationship between two variables in which both variables either increase or decrease together.

negative correlation
A relationship between two variables in which one variable increases when the other decreases.

zero correlation
A relationship between two variables in which one variable is not predictably related to the other.

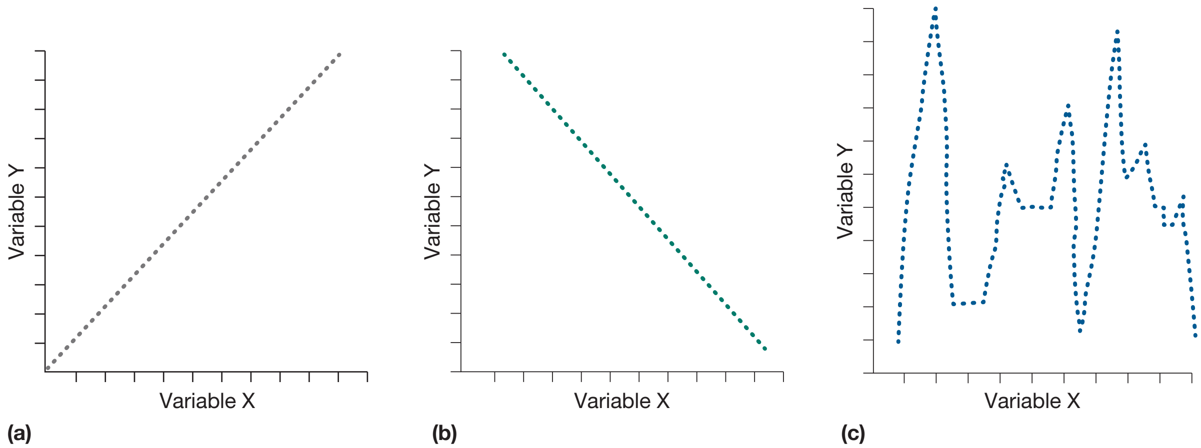


FIGURE 2.13
Direction of Correlation
(a) In a positive correlation, both variables "move" in the same direction. **(b)** In a negative correlation, the variables move in opposite directions. **(c)** In a zero correlation, one variable is not predictably related to a second variable.

is a *positive* correlation between these variables. The more they exercise, the more weight they *gain*. Why? Because exercise builds muscle mass. So if the gain of muscle mass exceeds the loss of fat, exercise will actually increase weight. Sometimes, the same phenomena can exhibit a negative correlation or a positive correlation, depending on the specific circumstances.

Now consider the positive correlation between smoking and cancer. The more a person smokes, the greater that person's risk of cancer. Does that relationship mean smoking causes cancer? Not necessarily. Just because two things are related, even strongly related, does not mean that one is causing the other. Many genetic, behavioral, and environmental variables may contribute both to whether a person chooses to smoke and to whether the person gets cancer. Complications of this kind prevent researchers from drawing causal conclusions from correlational studies. Two such complications are the directionality problem and the third variable problem.

DIRECTIONALITY PROBLEM One problem with correlational studies is in knowing the direction of the relationship between variables. This sort of ambiguity is known as the **directionality problem.** Consider this example. Suppose you survey a large group of people about their sleeping habits and their levels of stress. Those who report sleeping little also report having a higher level of stress. Does lack of sleep increase stress levels, or does increased stress lead to shorter and worse sleep? Both scenarios seem plausible:

Sleep (A) and stress (B) are correlated.

- Does less sleep cause more stress? (A → B)

  or

- Does more stress cause less sleep? (B → A)

THIRD VARIABLE PROBLEM Another drawback with all correlational studies is the **third variable problem.** Instead of variable A causing variable B, as a researcher might assume, it is possible that a third variable, C, causes both A and B. Consider the relationship between texting while driving and dangerous driving. It is possible that people who are risk takers in their daily lives are more likely to text while driving. It is also possible that these people are likely to drive dangerously. Thus, the cause of both texting while driving and dangerous driving is the third variable, risk-taking:

Texting while driving (A) is correlated with driving dangerously (B).

- Risk taking (C) causes some people to text while driving. (C → A)

  and

- Risk taking (C) causes some people to drive dangerously. (C → B)

Indeed, research has shown that those who text while driving are also likely to engage in a variety of other risky behaviors, such as not wearing seatbelts, riding with a driver who had been drinking, or even drinking alcohol and driving (Olsen, Shults, & Eaton, 2013). Thus, it is possible that both texting while driving and dangerous driving generally result from risk taking, a third variable.

Sometimes the third variable is obvious. Suppose you were told that the more churches there are in a town, the greater the rate of crime. Would you conclude that churches cause crime? In looking for a third variable, you would realize that the population size of the town affects the number of churches and the frequency of crime. But sometimes third variables are not so obvious and may not even be identifiable. It turns out that even the relationship between smoking and cancer is plagued by the third variable problem. Evidence indicates that there is indeed a genetic predisposition—a built-in vulnerability to smoking—that can combine with environmental factors to

directionality problem
A problem encountered in correlational studies; the researchers find a relationship between two variables, but they cannot determine which variable may have caused changes in the other variable.

third variable problem
A problem that occurs when the researcher cannot directly manipulate variables; as a result, the researcher cannot be confident that another, unmeasured variable is not the actual cause of differences in the variables of interest.

increase the probability that some people will smoke *and* that they will develop lung cancer (Paz-Elizur et al., 2003; Thorgeirsson et al., 2008). Thus, it is impossible to conclude on the basis of correlational research that one of the variables is *causing* the other.

FIGURE 2.14
Correlation or Causation?
According to the players on the 2013 Boston Red Sox baseball team, facial hair causes a person to play better baseball. After two newly bearded players made some game-saving plays, the rest of the team stopped shaving (Al-Khatib, 2013). Did their beards cause the Red Sox to win the World Series that year? The facial hair may have been correlated with winning, but it did not cause an increase in talent. The team won through ability, practice, and luck.

ETHICAL REASONS FOR USING CORRELATIONAL DESIGNS Despite such potentially serious problems, correlational studies are widely used in psychological science. Some research questions require correlational research designs for ethical reasons. For example, as mentioned earlier, it would be unethical to send drivers out into traffic and ask them to text as part of an experiment. Doing so would put the drivers and others at risk.

There are many important real-world experiences that we want to know about but would never expose people to as part of an experiment. Suppose you want to know if soldiers who experience severe trauma during combat have more difficulty learning new tasks after they return home than soldiers who have experienced less-severe trauma during combat. Even if you theorize that severely traumatic combat experiences *cause* later problems with learning, it would be unethical to induce trauma in some soldiers so that you could compare soldiers who had experienced different degrees of trauma. (Likewise, most research on psychopathology—psychological illness—uses the correlational method, because it is unethical to induce psychological disorders in people to study the effects.) For this research question, you would need to study the soldiers' ability to learn a new task after they had returned home. You might, for example, observe soldiers who were attempting to learn computer programming. The participants in your study would have to include some soldiers who had experienced severe trauma during combat and some who had experienced less-severe trauma during combat. You would want to see which group, on average, performed less well when learning the task.

MAKING PREDICTIONS Correlational studies can be used to determine that two variables are associated with each other. In the example just discussed, the variables would be trauma during combat and learning difficulties later in life. By establishing such connections, researchers are able to make predictions. If you found the association you expected between severe trauma during combat and learning difficulties, you could predict that soldiers who experience severe trauma during combat will—again, on average—have more difficulty learning new tasks when they return than soldiers who do not experience severe trauma during combat. Because your study drew on but did not control the soldiers' wartime experiences, however, you have not established a causal connection (**FIGURE 2.14**).

By providing important information about the natural relationships between variables, researchers are able to make valuable predictions. For example, correlational research has identified a strong relationship between depression and suicide. For this reason, clinical psychologists often assess symptoms of depression to determine suicide risk. Typically, researchers who use the correlational method use other statistical procedures to rule out potential third variables and problems with the direction of the effect. Once they have shown that a relationship between two variables holds even when potential third variables are taken into account, researchers can be more confident that the relationship is meaningful.

The Experimental Method Controls and Explains

Scientists ideally want to explain what causes a phenomenon. For this reason, researchers rely on the experimental method. In experimental research, the researcher has maximal control over the situation. Only the experimental method enables the researcher to control the conditions under which a phenomenon occurs and therefore to understand the cause of the phenomenon. In an **experiment,** the researcher manipulates one variable to measure the effect on a second variable.

An experiment also allows researchers to test multiple hypotheses to examine and refine their theory. Suppose researchers initially theorize that using a cell phone while driving impairs driving. This theory does not explain why the effect happens. Researchers can refine the theory to include possible mechanisms and then test hypotheses related to the refined versions of the more general theory.

Suppose the researchers then theorize that using a cell phone while driving impairs driving because drivers need to use their hands both to drive and to use cell phones. One hypothesis to test this theory is that using a hands-free cell phone while driving will cause fewer problems than holding the phone while talking and driving. Another hypothesis to test the same theory is that any use of the hands, such as eating, will impair driving.

An alternative theory is that taking your eyes off the road—to dial a number or read and respond to a text—is the main factor that affects driving. This theory might yield the hypothesis that any action the driver performs that takes his or her eyes off the road—such as reading a map or looking at the radio to change stations—will impair driving.

Yet another theory is that driving requires cognitive resources, such as the ability to pay attention and think about driving. This theory might yield the hypothesis that any activity the driver performs that requires attention or thought—such as thinking about a problem at school—will impair driving. Through experimentation, psychologists test hypotheses about the mechanisms they theorize are responsible for the effect they are studying.

MANIPULATING VARIABLES In an experiment, the independent variable (IV) is manipulated. That is, the researchers choose what the study participants do or are exposed to.

In a study on the effects of using a cell phone while driving, the IV would be the type of cell phone use. While in a driving simulator, some participants might simply hold the phone, some might have to answer questions over the phone, and some might have to read and answer text messages.

An IV has "levels," meaning the different values that are manipulated by the researcher. All IVs must have at least two levels: a "treatment" level and a "comparison" level. In the study of cell phone use and driving ability, the people who actively used the cell phone received the "treatment." A group of study participants who receive the treatment are the **experimental group.** Since in this hypothetical study, some participants talk on the cell phone and others text, there are actually two experimental groups.

In an experiment, you always want to compare your experimental group with at least one **control group.** A control group consists of similar (or identical) participants who receive everything the experimental group receives except for the treatment. In this example, the experimental group uses a cell phone to talk or text while driving. The control group simply holds a cell phone while driving. This use of a control group includes the possibility that simply the presence of a cell phone is disruptive. To test whether handling a cell phone is disruptive, the control group could be drivers not holding a cell phone.

The dependent variable (DV) is whatever behavioral effect is—or behavioral effects are—measured. For example, the researcher could measure how quickly the participants responded to red lights, how fast they drove, and the distance they maintained behind the car in front of them. The researcher would measure each of these DVs as a function of the IV, the type of cell phone use.

experiment

A research method that tests causal hypotheses by manipulating and measuring variables.

experimental group

The participants in an experiment who receive the treatment.

control group

The participants in an experiment who receive no intervention or who receive an intervention that is unrelated to the independent variable being investigated.

confound
Anything that affects a dependent variable and that may unintentionally vary between the experimental conditions of a study.

The benefit of an experiment is that the researcher can study the causal relationship between variables. If the IV (such as type of cell phone use) consistently influences the DV (such as driving performance), then the IV is assumed to cause the change in the DV.

ESTABLISHING CAUSALITY A properly performed experiment depends on rigorous control. Here, *control* means the steps taken by the researcher to minimize the possibility that anything other than the independent variable could be the cause of differences between the experimental and control groups.

A **confound** is anything that affects a dependent variable and that may unintentionally vary between the study's different experimental conditions. When conducting an experiment, a researcher needs to ensure that the only thing that varies is the independent variable. Control thus represents the foundation of the experimental approach, in that it allows the researcher to rule out alternative explanations for the observed data.

In the study of cell phone use and driving performance, what if a car with an automatic transmission is simulated to assess driving when participants are not using a cell phone, but a car with a manual transmission is simulated to assess performance when participants are texting? Given that manual transmissions require greater dexterity to operate than automatic transmissions, any apparent effect of texting on driving performance might actually be caused by the type of car and the fact that it requires greater use of the hands. In this example, the drivers' skills might be *confounded* with the type of transmission, making it impossible to determine the true effect of the texting.

Other potential confounds in research include changes in the sensitivity of the measuring instruments, such as a systematic change in a scale so that it weighs things more heavily in one condition than in another. Changes in the time of day or the season when the experiment is conducted can also confound the results. Suppose you conducted the texting and driving study so that the cell phone users were tested in snowy winter conditions and control participants were tested during dry, sunny weather. The road conditions associated with the season would be an obvious confound. The more confounds and thus alternative explanations that can be eliminated, the more confident a researcher can be that the change in the independent variable is causing the change (or effect) in the dependent variable. For this reason, researchers have to watch vigilantly for potential confounds. As consumers of research, we all need to think about confounds that could be causing particular results. (For a recap of the experimental method, see **FIGURE 2.15.**)

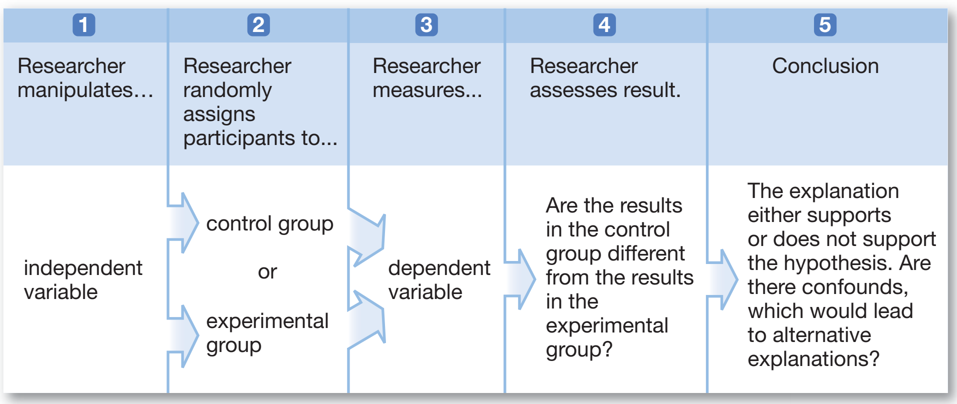


FIGURE 2.15 The Experimental Method in Action
Experiments examine how variables are related when one variable is manipulated by the researchers. The results can demonstrate causal relationships between the variables.

population
Everyone in the group the experimenter is interested in.

sample
A subset of a population.

Participants Need to Be Carefully Selected and Randomly Assigned to Conditions

An important issue for any research method is how to select participants for the study. Psychologists typically want to know that their findings *generalize* to people beyond the individuals in the study. In studying the effects of cell phone use on driving skills, you ultimately would not focus on the behavior of the specific participants. Instead, you would seek to discover general laws about human behavior. If your results generalized to all people, that would enable you, other psychologists, and the rest of humanity to predict, in general, how cell phone use would affect driving performance. Other results, depending on the nature of the study, might generalize to all college students, to students who belong to sororities and fraternities, to women, to men over the age of 45, and so on.

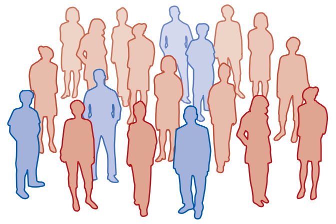


FIGURE 2.16
Population
The population is the group researchers want to know about (e.g., U.S. college students). For the results of an experiment to be considered useful, the participants should be representative of the population.

POPULATION AND SAMPLING The group you want to know about is the **population** (**FIGURE 2.16**). To learn about the population, you study a subset from it. That subset, the people you actually study, is the **sample.** *Sampling* is the process by which you select people from the population to be in the sample. In a case study, the sample size is one. The sample should represent the population, and the best method for making this happen is *random sampling* (**FIGURE 2.17**). This method gives each member of the population an equal chance of being chosen to participate. Further, larger samples yield more accurate results (**FIGURE 2.18**). However, sample size is often limited by resource constraints, such as time, money, and space in which to work.

Most of the time, a researcher will use a *convenience sample* (**FIGURE 2.19**). As the term implies, this sample consists of people who are conveniently available for the study. However, because a convenience sample does not use random sampling, the sample is likely to be biased. For instance, a sample of students at a small religious school may differ from a sample of students at a large state university. Researchers acknowledge the limitations of their samples when they present their findings.

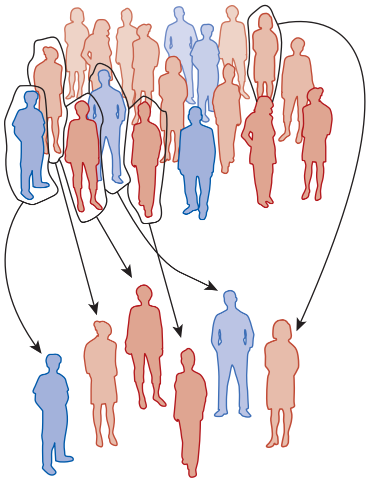


FIGURE 2.17
Random Sample
A random sample is taken at random from the population (e.g., selecting students from schools throughout the United States). The best method for making this happen is random sampling.

FIGURE 2.18 Larger Samples
Suppose researchers want to compare how many women go to the beach versus how many men do. Why might the results be more accurate if the researchers use a large sample (such as the big picture here) rather than a small sample (such as the detail)?

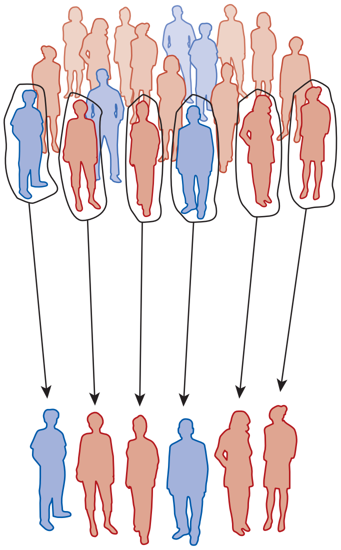


FIGURE 2.19 Convenience Sample
A convenience sample is taken from an available subgroup in the population (e.g., students at a particular school). Most of the time, circumstances force researchers to use a convenience sample.

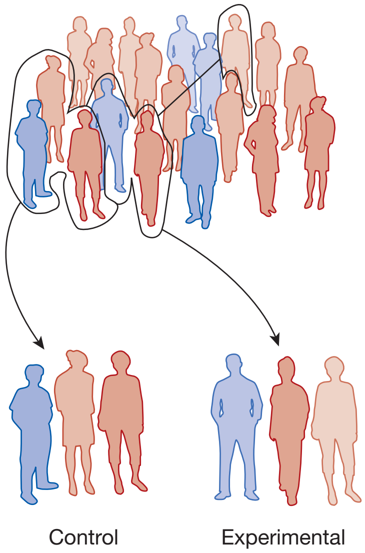


FIGURE 2.20 Random Assignment
In random assignment, participants are assigned at random to the control group or the experimental group. Random assignment is used when the experimenter wants to test a causal hypothesis.

RANDOM ASSIGNMENT Once researchers obtain a representative sample of the population, they use **random assignment** to assign participants to the experimental and control groups (**FIGURE 2.20**). Random assignment gives each potential research participant an equal chance of being assigned to any level of the independent variable.

For your study, there might be three levels: holding a cell phone, answering questions verbally over the phone, and answering questions by texting. First, you would gather participants by taking either a random sample or a convenience sample from the population. Then, to randomly assign those participants, you might have them draw numbers from a hat to determine who is assigned to the control group (holding the phone) and to each experimental group (one talking and the other texting).

Of course, individual differences are bound to exist among participants. For example, any of your groups might include some people with less experience with cell phones and some people who talk or text a great deal, some people with excellent and experienced driving skills and some people with comparably weaker skills. But these differences will tend to average out when participants are assigned to either the control or experimental groups randomly, so that the groups are equivalent *on average*. Random assignment tends to balance out known and unknown factors.

If random assignment to groups is not truly random, and groups are not equivalent because participants in different groups differ in unexpected ways, the condition is known as **selection bias** (also known as *selection threat*). Suppose you have two of the experimental conditions described earlier: a group assigned to hold the phone and a group assigned to respond to text messages. What happens if the group assigned to hold the phone includes many college students with lots of experience using cell phones and the other group includes many older adults who have minimal experience texting? How would you know if the people in the different conditions of the study are equivalent? You could match each group for age, sex, cell phone use habits, and so on, but you can never be sure that you have assessed all possible factors that may differ between the groups. Not using random assignment can create confounds that limit causal claims.

random assignment
Placing research participants into the conditions of an experiment in such a way that each participant has an equal chance of being assigned to any level of the independent variable.

selection bias
In an experiment, unintended differences between the participants in different groups; it could be caused by nonrandom assignment to groups.

GENERALIZING ACROSS CULTURES It is important for researchers to assess how well their results generalize to other samples, particularly in cross-cultural research (Henrich, Heine, & Norenzayan, 2010). One difficulty in comparing people from different cultures is that some ideas and practices do not translate easily across cultures, just as some words do not translate easily into other languages. Apparent differences between cultures may reflect such differences in language, or they may reflect participants' relative willingness to report things about themselves publicly. A central challenge for cross-cultural researchers is to refine their measurements to rule out these kinds of alternative explanations (**FIGURE 2.21**).

Some psychological traits are the same across all cultures (e.g., care for the young). Others differ widely across cultures (e.g., behaviors expected of adolescents). **Culturally sensitive research** takes into account the significant role that culture plays in how people think, feel, and act (Adair & Kagitcibasi, 1995; Zebian, Alamuddin, Mallouf, & Chatila, 2007). Scientists use culturally sensitive practices so that their research respects—and perhaps reflects—the "shared system of meaning" that each culture transmits from one generation to the next (Betancourt & Lopez, 1993, p. 630).

In cities with diverse populations, such as Toronto, London, and Los Angeles, cultural differences exist among different groups of people living in the same neighborhoods and having close daily contact. Researchers therefore need to be sensitive to cultural differences even when they are studying people in the same neighborhood or the same school. Researchers must also guard against applying a psychological concept from one culture to another without considering whether the concept is the same in both cultures. For example, Japanese children's attachment to their parents looks quite different from the attachment styles common among North American children (Miyake, 1993).

(a)

(b)

FIGURE 2.21
Cross-Cultural Studies
(a) The living space and treasured possessions of a family in Japan, for example, differ from **(b)** those of a family in Mali. Cross-cultural researchers might study how either family would react to crowding or to the loss of its possessions.

Summing Up

What Types of Studies Are Used in Psychological Research?

- Three main types of studies are used in psychological research: descriptive, correlational, and experimental.
- Descriptive and correlational designs are useful for describing and predicting behavior, but they do not allow researchers to assess causality.
- Only experiments allow researchers to determine causality.
- In an experiment, a researcher manipulates an independent variable to study how it affects a dependent variable, while controlling all other potential influences.
- When performing research, sampling allows researchers to draw a representative sample of the population and generalize the findings to the population.

Measuring Up

1. **The main reason researchers randomly assign participants to different conditions in an experiment is that**
   a. it is easier to assign participants to different conditions than it is to find people who naturally fit into different conditions.
   b. random assignment controls for any intuitions the participants may have at the start of the experiment.
   c. random assignment is used when there are ethical reasons for not using observational or correlational research designs.

culturally sensitive research
Studies that take into account the role that culture plays in determining thoughts, feelings, and actions.

d. random assignment helps to ensure that the experimental groups are (on average) equal and that any difference in the dependent variable is due to the participants' being in different experimental groups.

2. **Match each of the following with the research method it describes. Choose from among case study, correlational, experimental, naturalistic observation, and survey.**

   a. An end-of-semester course evaluation that asks students to rate the class.
   b. Collection of data showing that on average, students who studied more hours for a psychology examination earned higher grades.
   c. A study comparing the driving performance between people randomly assigned to text while driving or to drive without distractions.
   d. A research report describing a person with an extremely rare psychological disorder.
   e. A study comparing voting preferences for people in wealthy neighborhoods compared to people in middle-class neighborhoods.
   f. A study describing how 8-year-old children interacted on their school playground.
   g. A study comparing tumor size in three groups of mice, each given a different dose of nicotine.
   h. A study comparing the rate of cancer in people who are nonsmokers, light smokers, or heavy smokers.

ANSWERS: (1) d. random assignment helps to ensure that the experimental groups are (on average) equal and that any difference in the dependent variable is due to the participants' being in different experimental groups.
(2) a. survey; **b.** correlational; **c.** experimental; **d.** case study; **e.** correlational; **f.** naturalistic observation; **g.** experimental; **h.** correlational.

2.3 What Are the Ethics Governing Psychological Research?

Learning Objectives

- Identify ethical issues associated with conducting psychological research on human participants.
- Apply ethical principles to conducting research on animals, identifying the key issues regarding the humane treatment of animal subjects.

There Are Ethical Issues to Consider in Research with Human Participants

Psychologists want to know why and how we act, think, feel, and perceive the way we do. In other words, they want to understand the human condition. As a result, it makes sense for psychological studies to involve human participants. As in any science that studies human behavior, however, there are limits to how researchers can manipulate what people do in studies. For ethical and practical reasons, researchers cannot always use the experimental method.

Consider the question of whether smoking causes cancer. To explain why a phenomenon (e.g., cancer) occurs, experimenters must control the conditions under which that phenomenon occurs. And to establish that a cause-and-effect relationship exists between variables, experimenters need to use random assignment. So to determine causality between smoking and cancer, some study participants would have to be randomly "forced" to smoke a controlled number of cigarettes in a specific fashion for a controlled amount of time, while an equal number of different (but similar) participants would have to be randomly "prevented" from smoking for the same amount of time. However, ethics prevent researchers from randomly forcing people to smoke, so researchers cannot experimentally answer this question using human participants (**FIGURE 2.22**).

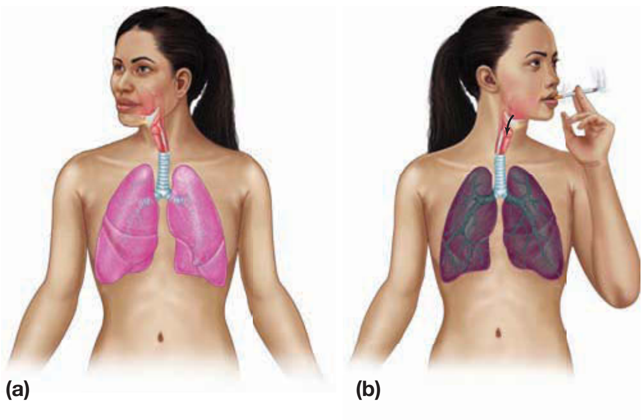


FIGURE 2.22
Research on Smoking and Cancer
Researchers can compare **(a)** a nonsmoker's lungs with **(b)** a smoker's lungs. They can compare the rates of cancer in nonsmokers with the rates of cancer in smokers. Ethically, however, they cannot perform an experiment that entails randomly forcing study participants to smoke, even though such experiments could help establish a link between smoking and cancer.

When conducting research, we have to carefully consider ethics. Is the study intended to do good for humanity? What exactly will the participants be asked to do? Are the requests reasonable, or will they put the participants in danger of physical or emotional harm over the short term or long term? Are the burdens of research shared justly among the portions of society that are involved?

INSTITUTIONAL REVIEW BOARDS (IRBS) To ensure the health and well-being of all study participants, strict guidelines exist regarding research. These guidelines are shared by all places where research is conducted, including colleges, universities, and research institutes. **Institutional review boards (IRBs)** are the guardians of the guidelines.

Convened at schools and other institutions where research is done, IRBs consist of administrators, legal advisers, trained scholars, and members of the community. At least one member of the IRB must not be a scientist. The purpose of the IRB is to review all proposed research to ensure that it meets scientific and ethical standards to protect the safety and welfare of participants. Most scientific journals today ask for proof of IRB approval before publishing research results. Four key issues are addressed in the IRB approval process: privacy, relative risks, informed consent, and access to data.

PRIVACY One major ethical concern about research is the expectation of privacy. Two main aspects of privacy must be considered. One aspect is *confidentiality*. This term means that personal, indentifying information about participants absolutely cannot be shared with others. Research participants must be assured that any such information collected in a study will remain private. In some studies, *anonymity* is used. Although this term is often confused with confidentiality, anonymity means that the researchers do not collect personal, identifying information. Without such information, responses can never be traced to any individual. Anonymity helps make participants comfortable enough to respond honestly.

Another important aspect of privacy is participants' knowledge that they are being studied. If behaviors are going to be observed, is it okay to observe people without their knowledge? This question obviously depends on what sorts of behaviors researchers might be observing. If the behaviors tend to occur in public rather than in private, researchers might be less concerned about observing people without their knowledge. For example, even without their knowledge, it would be okay to observe people texting while they walk. The concern over privacy is compounded by the ever-increasing technology for monitoring people remotely. Although it might be useful to compare men's and women's behaviors in public bathrooms, it would not be acceptable to install discreet video cameras to monitor people in restrooms.

RELATIVE RISKS OF PARTICIPATION Another ethical issue is the relative risk to participants' mental or physical health. Researchers must always remain aware of what they are asking of participants. They cannot ask people to endure unreasonable amounts of pain or of discomfort, either from stimuli or from the manner in which data measurements are taken.

Fortunately, in the vast majority of studies being conducted, these types of concerns are not an issue. However, even though risk may be low, researchers still have to think carefully about the potential for risk. Therefore, the IRB will evaluate the relative trade-off between risk and benefit for any research study it approves. In some cases, the potential gains from the research may require asking participants to

institutional review boards (IRBs)
Groups of people responsible for reviewing proposed research to ensure that it meets the accepted standards of science and provides for the physical and emotional well-being of research participants.

expose themselves to some risk to obtain important findings. The *risk/benefit ratio* is an analysis of whether the research is important enough to warrant placing participants at risk. If a study has any risk associated with it, then participants must be notified *before* they agree to participate. This process is known as *informed consent*.

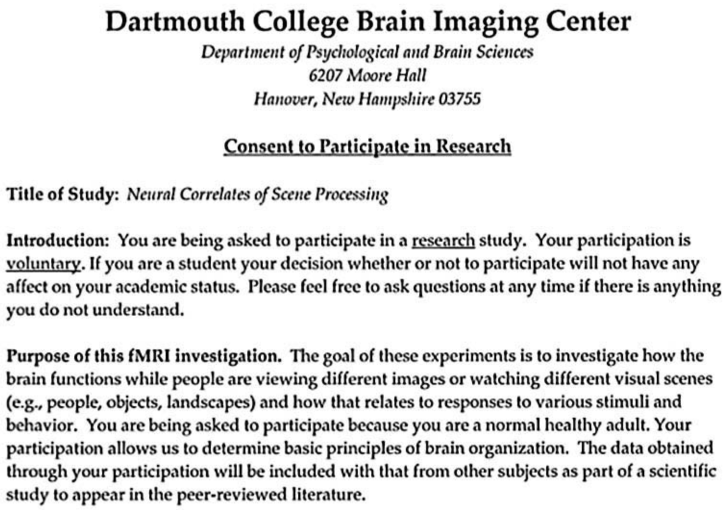
INFORMED CONSENT Research involving human participants is a partnership based on mutual respect and trust. People who volunteer for psychological research have the right to know what will happen to them during the course of the study. Compensating people either with money or course credit for their participation in research does not alter this fundamental right. Ethical standards require giving people all relevant information that might affect their willingness to become participants (**FIGURE 2.23**).

FIGURE 2.23
Informed Consent
The need for informed consent is illustrated by one of the most infamous unethical studies. Between 1932 and 1972, the U.S. Public Health Service and the Tuskegee Institute, in Alabama, studied the natural progression of untreated syphilis in rural African American men. Without their knowledge, 400 impoverished men with the venereal disease were randomly assigned to receive treatment or not. In 1987, the U.S. government publicly apologized to the participants and their families. Here, President Bill Clinton and Vice President Al Gore appear at a news conference with participant Herman Shaw.

Informed consent means that participants make a knowledgeable decision to participate. Typically, researchers obtain informed consent in writing (**FIGURE 2.24**). In observational studies of public behavior, the observed individuals remain anonymous to the researchers to protect their privacy, so informed consent is not required. People under the age of 18 and those with severe cognitive disabilities or mental health disorders cannot legally provide informed consent. If such an individual is to participate in a study, a legal guardian must grant permission.

It is not always possible to inform participants fully about a study's details. If knowing the study's specific goals may alter the participants' behavior, thereby rendering the results meaningless, researchers may need to use deception. That is, they might mislead the participants about the study's goals or not fully reveal what will take place. Researchers use deception only when other methods are not appropriate and when the deception does not involve situations that would strongly affect people's willingness to participate. If deception is used, a careful *debriefing* must take place after the study's completion. Here, the researchers inform the participants of the study's goals. They also explain the need for deception, to eliminate or counteract any negative effects produced by the deception.

ACCESS TO DATA No matter what research method they use, researchers must also consider who will have access to the data they collect. Participant confidentiality should always be guarded carefully so that personal information is not linked publicly to the study's findings. When participants are told that their information will remain confidential, the implicit promise is that their information will be kept secret or made available to only the few people who need to know it. Often the quality and accuracy of data depend on the participants' certainty that their responses will be kept confidential. When emotionally or legally sensitive topics are involved, people are especially likely to provide valid data after they are promised confidentiality.



Dartmouth College Brain Imaging Center
Department of Psychological and Brain Sciences
6207 Moore Hall
Hanover, New Hampshire 03755

Consent to Participate in Research

Title of Study: *Neural Correlates of Scene Processing*

Introduction: You are being asked to participate in a research study. Your participation is voluntary. If you are a student your decision whether or not to participate will not have any affect on your academic status. Please feel free to ask questions at any time if there is anything you do not understand.

Purpose of this fMRI investigation. The goal of these experiments is to investigate how the brain functions while people are viewing different images or watching different visual scenes (e.g., people, objects, landscapes) and how that relates to responses to various stimuli and behavior. You are being asked to participate because you are a normal healthy adult. Your participation allows us to determine basic principles of brain organization. The data obtained through your participation will be included with that from other subjects as part of a scientific study to appear in the peer-reviewed literature.

FIGURE 2.24
Informed Consent Form
This portion of an approved form gives you a sense of how researchers typically obtain informed consent in writing.

There Are Ethical Issues to Consider in Research with Animals

Many people have ethical concerns about research with nonhuman animals. These concerns involve two questions: Does research threaten the health and well-being of the animals? And is it fair to the animals to study them to improve the human condition?

Using Psychology in Your Life

Should I Participate in Psychological Research?

Someday, perhaps even this term, you will be invited to participate in a psychological research study (**FIGURE 2.25**). Because psychological researchers are a creative lot, they enjoy figuring out clever ways to study the human mind. As a result, participation in research can be a lot of fun. Even studies that simply involve answering self-report questions offer opportunities to reflect on your inner world and behaviors. However, some students in introductory psychology may worry that researchers will trick them into doing something they do not want to do. Others may feel anxious because they have no idea what to expect once they walk through the doors of a psychology laboratory. Understanding the ethical principles that guide psychological research arms potential research participants—like yourself—with insight about what to expect when participating in a study.

Psychologists in the United States conduct their studies according to a set of ethical principles called the Belmont Report. To read the full report, go to http://www.hhs.gov/ohrp/humansubjects/guidance/belmont.html. These principles, a few of which are described below, guide many aspects of participants' experiences in research studies.

First, no one can force you to participate in a study. Although many psychology departments "require" students to participate in research as part of their course work, they offer students alternatives for fulfilling this requirement. For example, in some departments, students can read and write about articles published in journals in lieu of participating in research. Even if you volunteer for a study, you have the right to discontinue your participation at any time, for any reason, and without penalty. And you can skip any questions you do not care to answer, perhaps because you find them intrusive or offensive. You are in the driver's seat when it comes to choosing if, and to what extent, you would like to participate in a study.

Second, you are legally and ethically entitled to know what you are getting

FIGURE 2.25
Student Participation in Psychological Research
These students are enjoying the opportunity to contribute to scientific knowledge. Join them by participating in a study.

"WHAT IT COMES DOWN TO IS YOU HAVE TO FIND OUT WHAT REACTION THEY'RE LOOKING FOR, AND YOU GIVE THEM THAT REACTION."

HEALTH AND WELL-BEING Research with animals must always be conducted with regard to the health and well-being of the animals. Federal mandates govern the care and use of animals in research, and these mandates are strictly enforced. An accounting and reporting system is in place for all institutions conducting animal research. Violators of the mandates are prevented from conducting further research.

All colleges, universities, and research institutions conducting research with vertebrate animals must have an Institutional Animal Care and Use Committee (IACUC). This committee is like an institutional review board (discussed earlier), but it evaluates animal research proposals. In addition to scientists and nonscientists, every IACUC includes a certified doctor of veterinary medicine, who must review each proposal to ensure that the research animals will be treated properly before, during, and after the study.

Research facilities must comply with the IACUC's standards. Facilities are given scheduled and surprise inspections. Noncompliance can result in suspended or terminated research, monetary fines, federal charges, and even jail time.

into so you can make an informed decision about participating. Although the researchers will not be able to reveal their exact research questions and hypotheses, they will be able to tell you the general purpose of the study and the kinds of activities you will be asked to complete. You might be asked to answer questions, perform computer tasks, engage in moderate physical activity, navigate a real or imagined social scenario, rate the appeal of different consumer products, and so on. In addition, researchers must tell you about the risks and potential benefits faced by participants. For example, researchers studying ostracism would inform participants they might find the experimental tasks distressing. So even before a study begins, you will actually know a good deal about the research.

Third, after you complete the study, you can expect the researchers to debrief you. During the debriefing, the researchers will tell you if they used deception in the study. For example, if you participate in a study about cooperation, you might learn during the debriefing that the "person" you interacted with online was really a computer program.

Finally, you can expect that the data you provide will remain confidential. To protect confidentiality, the researchers will remove all identifying information, such as your name, from any data you submit. They will store consent forms separately from data, password-protect electronic files containing sensitive information, and keep all files in a secure location.

While researchers are governed by formal ethical guidelines (in addition to their own moral compasses), good study participants also engage the research process respectfully. When you sign up to participate in a study, record the researcher's contact information in case an emergency arises and you are unable to fulfill your commitment. Arrive at your session on time, and bring any paperwork your institution might require in order for you to receive class credit for your participation. During the study, minimize potential distractions, such as by turning off your cell phone. And, importantly, ask questions! One of the benefits of volunteering in research is learning firsthand about the research process. Getting answers to your questions helps you derive this benefit.

Study participants are essential to the research enterprise. The principles and procedures described here emerged out of concern for the well-being of participants. Understanding your rights and responsibilities prepares you to contribute meaningfully and confidently, without fear of trickery or unknown risks, to psychologists' efforts to understand and improve the human condition. On behalf of psychologists everywhere, thank you for joining us in this endeavor.

FAIRNESS Animals are not used to study aspects of the human condition because animals are not the same as humans. However, some species share similarities with humans that make them good "models" for particular human behaviors or conditions. For example, as you will learn more about in Chapters 3 and 7, the human brain has a region called the hippocampus, and people with damage to this region suffer from memory loss. It would be unethical for researchers to reproduce hippocampal damage in people in an effort to find treatments for their memory loss. However, many animals also have a hippocampus, and they display similar types of memory loss when this region is damaged. As a way to help humans, researchers thus may find it necessary to conduct animal research. For example, scientists can damage or temporarily "turn off" the hippocampus in rats or mice to test treatments that may help to reverse the resulting memory loss.

Another valuable animal model is the transgenic mouse. Transgenic mice have been produced by manipulating genes in developing mouse embryos—for example, by inserting strands of foreign DNA into the genes. Studying the behavior of mice with

FIGURE 2.26 Animal Research
Researchers observe the behaviors of transgenic mice to understand how certain genes affect behavior.

specific genetic changes allows scientists to discover the role that genes play in behavior and disease (**FIGURE 2.26**).

Are such treatments fair to the research animals? Scientists must balance their concern for individual animals' lives with their concern for humanity's future. The pursuit of scientific knowledge and medical advances is noble, and animals' lives are given a kind of nobility—a meaning—when the animals are used respectfully in research.

Summing Up

What Are the Ethics Governing Psychological Research?

- Psychological researchers must consider the ethical consequences of their data collection.
- Strict rules govern research with both human participants and research animals.
- Each research study with human participants is evaluated for scientific and ethical validity. The evaluation is done by an Institutional Review Board (IRB), which consists of scientists and nonscientists.
- The four key issues addressed in the IRB approval process are privacy, relative risks, informed consent, and access to data.
- Each animal research study is evaluated by an Institutional Animal Care and Use Committee (IACUC), which consists of scientists, nonscientists, and a veterinarian. The IACUC ensures the ethical treatment of the animals before, during, and after the study.

Measuring Up

Determine whether each of the following statements is true (T) or false (F).

1. _____ Confidentiality is the same as anonymity, because both mean that study results are not revealed to nonscientists.
2. _____ Even if research does not involve deception, it still needs to be approved by an IRB.
3. _____ Informed consent is required only when a research study poses a risk to safety or health.
4. _____ Students who participate in psychological research to receive course credit give up their right to privacy.
5. _____ Ethical rules govern research with both human participants and animals.
6. _____ Any team of animal researchers must include a veterinarian.
7. _____ Violations in the ethical treatment of animals in research may be justified if the study has sufficient scientific merit.
8. _____ An IRB reviews proposals for research with humans, whereas an IACUC reviews animal research proposals.

ANSWERS: 1. F; **2.** T; **3.** F; **4.** F; **5.** T; **6.** F; **7.** F; **8.** T.

2.4 How Are Data Analyzed and Evaluated?

So far, this chapter has presented the essential elements of scientific inquiry in psychology: thinking critically; asking an empirical question using theories, hypotheses, and research; deciding what type of study to run; considering the ethics of particular research; collecting and presenting data. This section focuses on the data. Specifically, it examines the characteristics that make for good data and the statistical procedures that researchers use to analyze data.

Learning Objectives

- Identify three characteristics that reflect the quality of data.
- Describe measures of central tendency and variability.
- Describe the correlation coefficient.
- Discuss the rationale for inferential statistics.

Good Research Requires Valid, Reliable, and Accurate Data

If you collect data to answer a research question, the data must be *valid*. That is, the data must accurately measure the constructs (concepts) that you think they measure, accurately represent phenomena that occur outside of the laboratory, and accurately reveal effects due specifically and only to manipulation of the independent variable.

Construct validity is the extent to which variables measure what they are supposed to measure. For example, suppose at the end of the semester your psychology professor gives you a final examination that consists of chemistry problems. This kind of final examination would lack construct validity—it would not accurately measure your knowledge of psychology (**FIGURE 2.27**).

Now imagine you are a psychological researcher. You hypothesize that "A students" spend more time studying than "C students." To test your hypothesis, you assess the amount of time students spend studying. However, what if "C students" tended to do other things—such as sleeping, playing video games, or checking their Facebook status—while they claimed to be studying? If this were the case, the data would not accurately reflect studying and would therefore lack construct validity.

External validity is the degree to which the findings of a study can be generalized to other people, settings, or situations. A study is externally valid if (1) the participants accurately represent the intended population, and (2) the variables were manipulated and measured in ways similar to how they occur in the "real world."

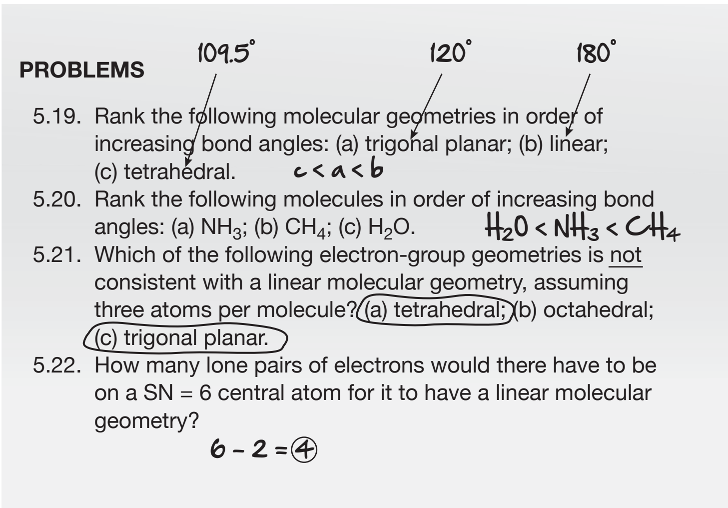
Internal validity is the degree to which the effects observed in an experiment are due to the independent variable and not to confounds. For data to be internally valid, the experiment must be well designed and well controlled. That is, all the participants must be as similar as possible, and there must be a control group. Only by comparing experimental groups to control groups can you determine that any changes observed in the experimental groups are caused by the independent variable and not something else (for example, practice or the passage of time).

To understand internal validity, suppose you are conducting a study to see if special tutoring causes better grades. You randomly sample 50 students from introductory psychology classes at your university and give them special tutoring for 6 weeks. At the end of the 6 weeks, you find that the students earned an average score of

construct validity
The extent to which variables measure what they are supposed to measure.

external validity
The degree to which the findings of a study can be generalized to other people, settings, or situations.

internal validity
The degree to which the effects observed in an experiment are due to the independent variable and not confounds.



PROBLEMS

109.5° 120° 180°

5.19. Rank the following molecular geometries in order of increasing bond angles: (a) trigonal planar; (b) linear; (c) tetrahedral. $c < a < b$

5.20. Rank the following molecules in order of increasing bond angles: (a) NH_3; (b) CH_4; (c) H_2O. $H_2O < NH_3 < CH_4$

5.21. Which of the following electron-group geometries is not consistent with a linear molecular geometry, assuming three atoms per molecule? (a) tetrahedral; (b) octahedral; (c) trigonal planar.

5.22. How many lone pairs of electrons would there have to be on a SN = 6 central atom for it to have a linear molecular geometry?

$6 - 2 = 4$

FIGURE 2.27
Construct Validity
Imagine having to answer questions like this on your psychology final. The results would lack construct validity because the course is about psychology, not chemistry.

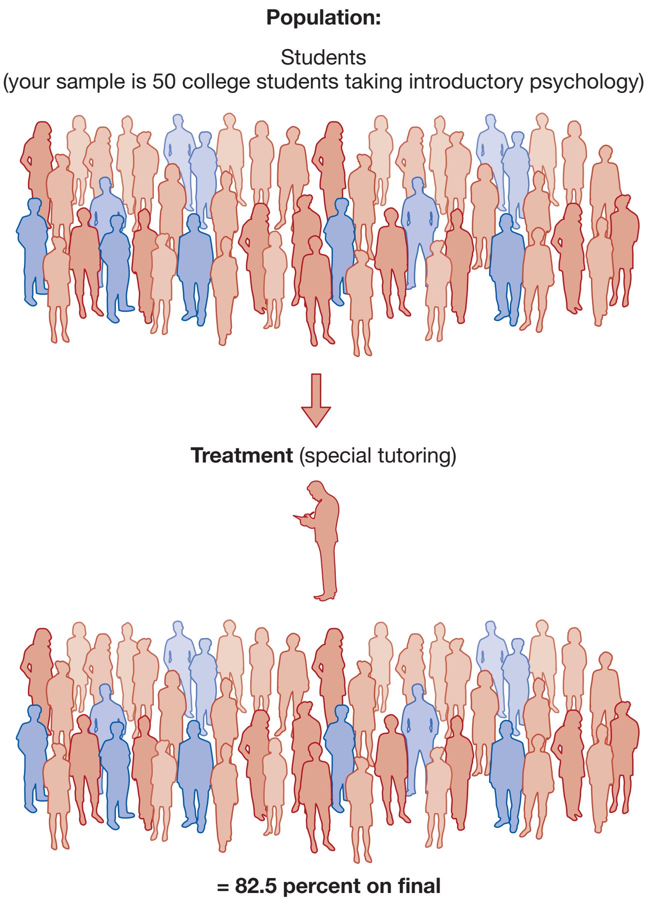


FIGURE 2.28 A Study Lacking Internal Validity
In this study, your entire population is one experimental group, which receives the treatment of special tutoring. You determine the group's average score on the final exam, but you cannot compare that result to a control group.

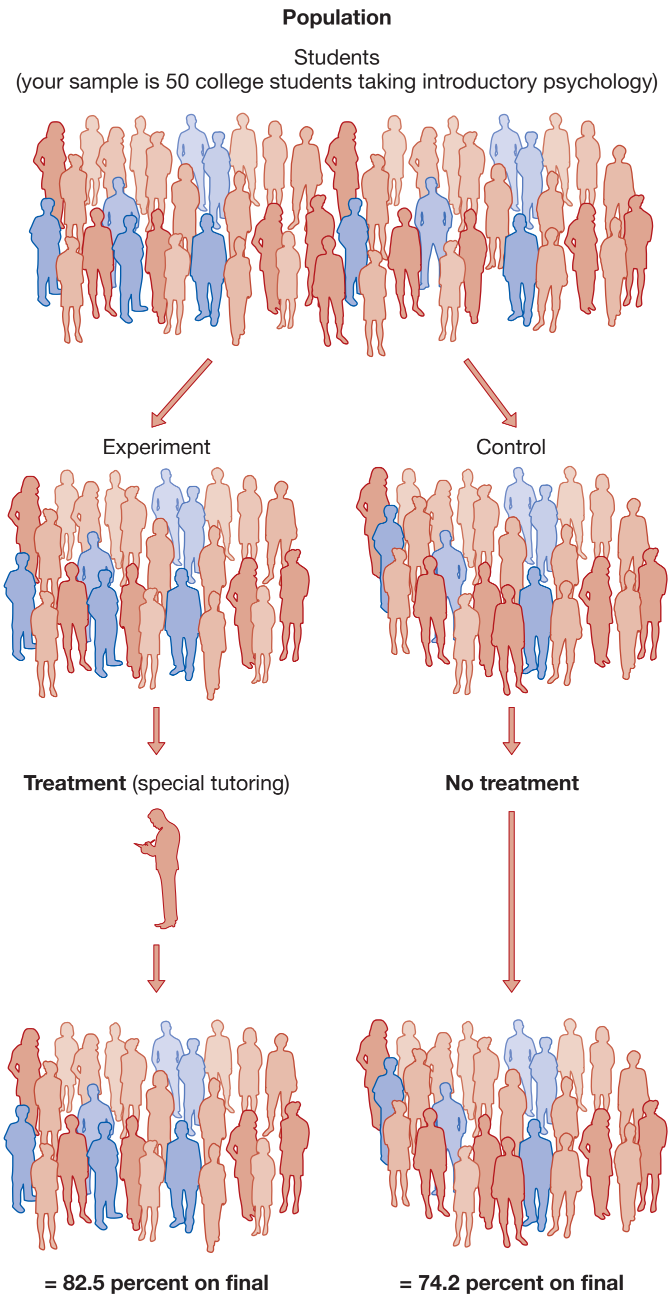


FIGURE 2.29 A Study with Internal Validity
In this better study, you divide the population into an experimental group and a control group. Only the experimental group receives the treatment. You can then compare the results with the results from the control group.

82.5 percent on the final exam (**FIGURE 2.28**). Can you conclude that the tutoring caused the grade? Wait a minute. How do you know if 82.5 is an improvement over scores typically received on the exam? Maybe all students in introductory psychology "mature" over the semester so that the average final exam grade is about 82, regardless of tutoring. Or perhaps having 6 weeks of practice taking other tests results in higher exam grades, even without tutoring. Only by having an equal comparison group—a control group of students who are otherwise identical to the experimental group except for the treatment—can you determine if your treatment caused the observed effect.

Indeed, a better way to conduct this study would be to sample 50 students from the class, randomly assign 25 of them the special tutoring for 6 weeks (the experimental group), and not give any special treatment to the other 25 (the control group). Say the 25 students in the experimental group average 82.5 percent on the final exam and the 25 students in the control group average 74.2 percent (**FIGURE 2.29**). The control

reliability
The degree to which a measure is stable and consistent over time.

accuracy
The degree to which an experimental measure is free from error.

descriptive statistics
Statistics that summarize the data collected in a study.

group was similar in every way to the experimental group. As a result, you are fairly safe to conclude that the tutoring—not something else—led to higher exam grades. Thus, having a true control group can ensure that a study maintains internal validity.

Another important aspect of data is **reliability,** the stability and consistency of a measure over time. If the measurement is reliable, the data collected will not vary substantially over time. For instance, one option for measuring the duration of studying would be to have an observer use a stopwatch. There is likely to be some variability, however, in when the observer starts and stops the watch relative to when the student actually starts studying. As a consequence, the data in this scenario would be less reliable than data collected by an online homework system that measured how much time students spent working on assignments.

FIGURE 2.30
Random Error
Data accuracy can be affected by random error. For example, say you time the same research participant several times. The stopwatch works accurately. But because your judgment of starting and stopping times differs each time, the degree of error varies each time.

The third and final characteristic of good data is **accuracy,** the degree to which the measure is error free. A measure may be reliable but still not be accurate. Psychologists think about this problem by turning it on its head and asking, How do errors creep into a measure?

Suppose you use a stopwatch to measure the duration of studying. The problem with this method is that each measurement will tend to overestimate or underestimate the duration (because of human error or variability in recording times). This type of problem is known as a *random error* or *unsystematic error.* Although an error is introduced into each measurement, the value of the error differs each time (**FIGURE 2.30**). But suppose the stopwatch has a glitch, so that it always overstates the time measured by 1 minute. This type of problem is known as a *systematic error* or *bias,* because the amount of error introduced into each measurement is constant (**FIGURE 2.31**). Generally, systematic error is more problematic than random error because the latter tends to average out over time and therefore is less likely to produce inaccurate results.

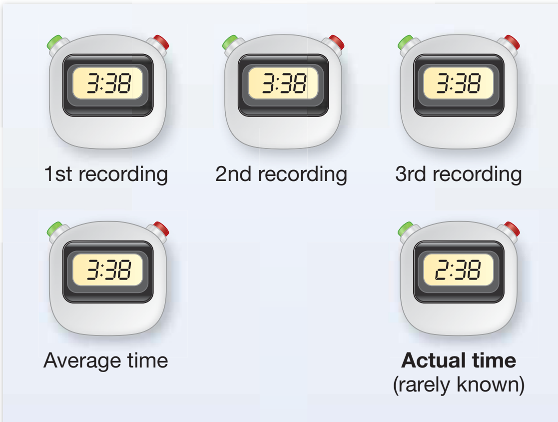


FIGURE 2.31
Systematic Error
Data accuracy can be affected by systematic error. Here, you time the same research participant several times, but the stopwatch is off by 1 minute each time. The degree of error is constant.

Descriptive Statistics Provide a Summary of the Data

The first step in evaluating data is to inspect the *raw values.* This term refers to data that are as close as possible to the form in which they were collected. In examining raw data, researchers look for errors in data recording. For instance, they assess whether any of the responses seem especially unlikely (e.g., studying for 72 hours or a 113-year-old participant). Once the researchers are satisfied that the data make sense, they summarize the basic patterns using **descriptive statistics.** These mathematical forms provide an overall summary of the study's results. For example, they might show how the participants, on average, performed in one condition compared with another.

The simplest descriptive statistics are measures of **central tendency.** This single value describes a typical response or the behavior of the group as a whole. The most intuitive measure of central tendency is the **mean,** the arithmetic average of a set of numbers. The class average on an exam is an example of a mean score. Consider our earlier hypothetical study of cell phone use and driving performance. A basic way to summarize the data would be to calculate the means for driving performances using number of seconds they took to travel once around a virtual racetrack in a driving simulator: You would calculate one mean for when participants were simply holding a cell phone and a second mean for when they were texting. If texting affects driving, you would expect to see a difference in the means between those holding cell phones and those using them.

central tendency
A measure that represents the typical response or the behavior of a group as a whole.

mean
A measure of central tendency that is the arithmetic average of a set of numbers.

median
A measure of central tendency that is the value in a set of numbers that falls exactly halfway between the lowest and highest values.

mode
A measure of central tendency that is the most frequent score or value in a set of numbers.

A second measure of central tendency is the **median,** the value in a set of numbers that falls exactly halfway between the lowest and highest values. For instance, if you received the median score on a test, half the people who took the test scored lower than you and half the people scored higher.

Sometimes researchers will summarize data using a median instead of a mean because if one or two numbers in the set are dramatically larger or smaller than all the others, the mean will give either an inflated or a deflated summary of the average. This effect occurs in studies of average incomes. Perhaps approximately 50 percent of Americans make more than $52,000 per year, but a small percentage of people make so much more (multiple millions or billions for the richest) that the mean income is much higher (around $70,000) than the median and is not an accurate measure of what most people earn. The median provides a better estimate of how much money the average person makes.

A third measure of central tendency is the **mode,** the most frequent score or value in a set of numbers. For instance, the modal number of children in an American family is two, which means that more American families have two children than any other number of children. (For examples of how to calculate all three central tendency measures, see **FIGURE 2.32.**)

You measure the number of seconds that 11 participants take to drive around a simulated racetrack:

- One takes 55 seconds.
- One takes 69 seconds.
- One takes 56 seconds.
- One takes 65 seconds.
- One takes 60 seconds.
- Two take 45 seconds.
- One takes 48 seconds.
- One takes 38 seconds.
- One takes 34 seconds.
- One takes 25 seconds.

Written in ascending order, the number of seconds per participant looks like this:

25 34 38 45 45 48 55 56 60 65 69

Mean
The arithmetic average of a set of numbers

$$\frac{\text{total \# of seconds}}{\text{total \# of participants}} = \frac{25+34+38+45+45+48+55+56+60+65+69}{11} = \frac{540}{11} = \mathbf{49}$$

Median
The value that falls exactly halfway between the lowest and highest values

25 34 38 45 45 48 55 56 60 65 69 = **48**

Mode
The most frequent score or value in a set of numbers

25 34 38 **45 45** 48 55 56 60 65 69 = **45**

Range
The distance between the largest and smallest values

25 34 38 45 45 48 55 56 60 65 **69** = **69** – **25** = **44**

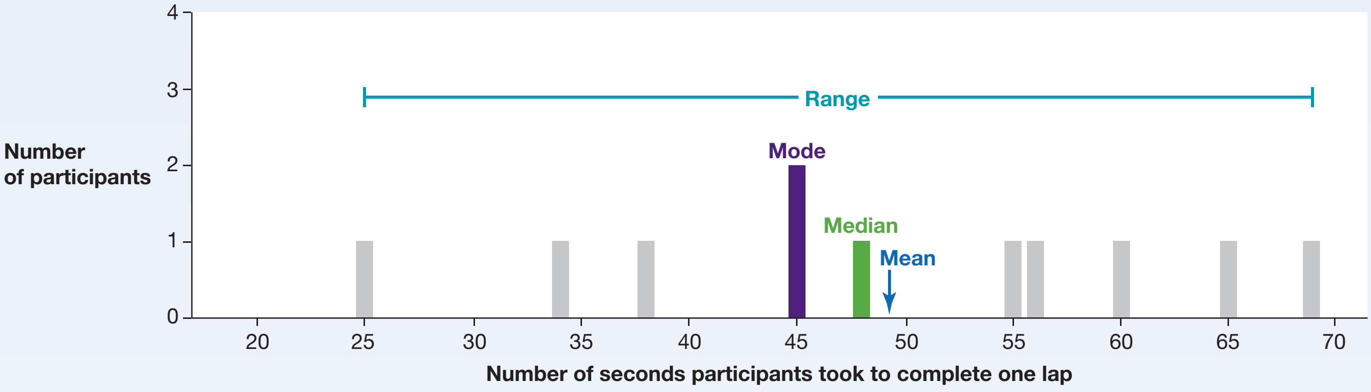


FIGURE 2.32 Descriptive Statistics
Descriptive statistics are used to summarize a data set and to measure the central tendency and variability in a set of numbers. The mean, median, and mode are different measures of central tendency. The range is a measure of variability.

In addition to measures of central tendency, another important characteristic of data is the **variability** in a set of numbers. In many respects, the mean is meaningless without knowing the variability. Variability refers to how widely dispersed the values are from each other and from the mean. The most common measure of variability—how spread out the scores are—is the **standard deviation.** This measure reflects how far away each value is, on average, from the mean. For instance, if the mean score for an exam is 75 percent and the standard deviation is 5, most people scored between 70 percent and 80 percent. If the mean remains the same but the standard deviation becomes 15, most people scored between 60 and 90—a much larger spread.

Another measure of how spread out scores are is the *range,* the distance between the largest value and the smallest value. Often the range is not very useful, however, because it is based on only those two scores.

variability
In a set of numbers, how widely dispersed the values are from each other and from the mean.

standard deviation
A statistical measure of how far away each value is, on average, from the mean.

scatterplot
A graphical depiction of the relationship between two variables.

correlation coefficient
A descriptive statistic that indicates the strength of the relationship between two variables.

Correlations Describe the Relationships Between Variables

The descriptive statistics discussed so far are used for summarizing the central tendency and variability in a set of numbers. Descriptive statistics can also be used to summarize how two variables relate to each other. The first step in examining the relationship between two variables is to create a **scatterplot.** This type of graph provides a convenient picture of the data (**FIGURE 2.33**).

In analyzing the relationship between two variables, researchers can compute a **correlation coefficient.** This descriptive statistic provides a numerical value (between −1.0 and +1.0) that indicates the strength of the relationship between the two variables. Some sample scatterplots and their corresponding correlation coefficients can be seen in **FIGURE 2.34.**

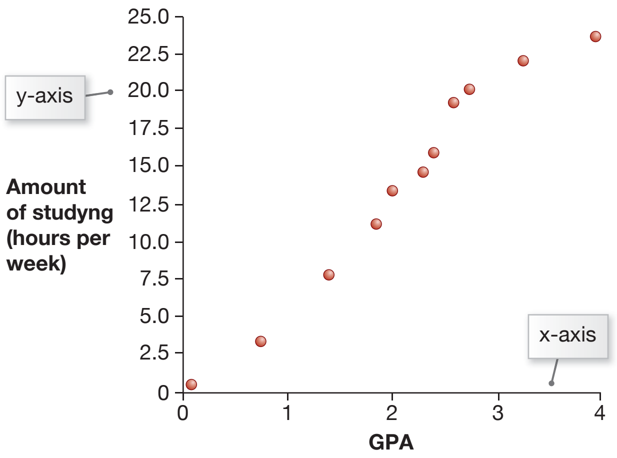


FIGURE 2.33 Scatterplots
Scatterplots are graphs that illustrate the relationship between two variables. In general, as this scatterplot indicates, study time is positively correlated with GPA.

Here we are considering only one type of relationship: a linear relationship. In a linear relationship, an increase or decrease in one variable is associated with an increase or decrease in the other variable. When a linear relationship is strong, knowing how people measure on one variable enables you to predict how they will measure on the other variable. The two types of linear relationship, as discussed in Section 2.2, are positive correlations and negative correlations.

If two variables have a positive correlation, they increase or decrease together. For example, the more people study, the more likely they are to have a higher GPA.

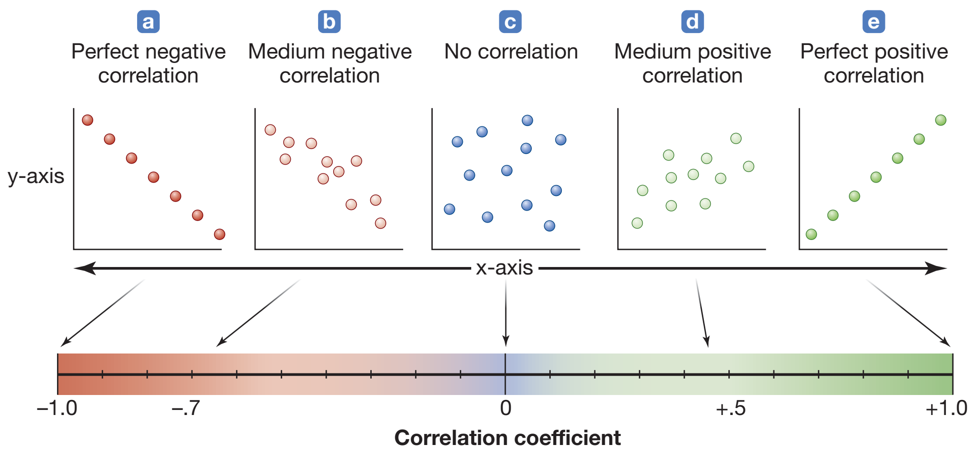
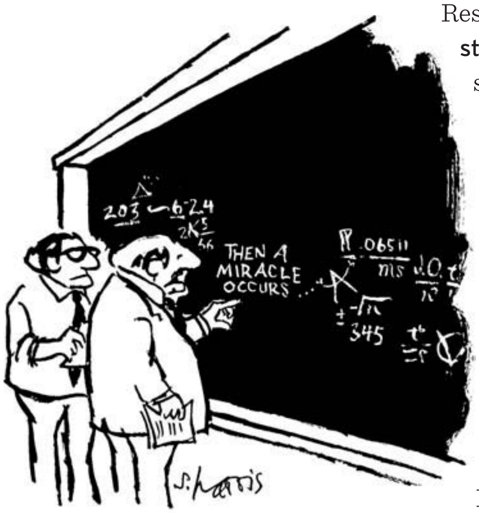


FIGURE 2.34
Correlation Coefficient
Correlations can have different values between -1.0 and +1.0. These values reveal different kinds of relationships between two variables. The greater the scatter of values, the lower the correlation. A perfect correlation occurs when all the values fall on a straight line.

A perfect positive correlation is indicated by a value of +1.0 (see Figure 2.34e). If two variables have a *negative correlation,* as one increases in value, the other decreases in value. For example, as people spend more time multitasking, they become less able to study for their exams, so multitasking and GPA have a negative correlation. A perfect negative correlation is indicated by a value of −1.0 (see Figure 2.34a). If two variables show no apparent relationship, the value of the correlation will be a number close to zero (assuming a linear relationship for the purposes of this discussion; see Figure 2.34c).

Inferential Statistics Permit Generalizations

Researchers use descriptive statistics to summarize data sets. They use **inferential statistics** to determine whether effects actually exist in the populations from which samples were drawn. For instance, suppose you find that the mean driving performance for drivers using cell phones is lower than the mean driving performance for those not using cell phones. How different do these means need to be for you to conclude that using a cell phone reduces people's ability to drive?



"I think you should be more explicit here in step two."

A review of 206 studies found that the skills necessary to drive a car can become impaired when people perform a second task (i.e., multitask; Ferdinand & Menachemi, 2014). Pretend for a moment, however, that cell phone use does not influence driving performance. If you measure the driving performances of those using cell phones and those not using them, just by chance there will be some variability in the mean performance of the two groups. The key is that if cell phone use does not affect driving performance, the probability of showing a large difference between the two means is relatively small. Researchers use statistical techniques to determine if the differences among the sample means are (probably) chance variations or if they reflect actual differences in the populations.

When the results obtained from a study would be very unlikely to occur if there really were no differences between the groups of subjects, the researchers conclude that the results are *statistically significant.* According to generally accepted standards, researchers typically conclude there is a significant effect only if the obtained results would occur by chance less than 5 percent of the time.

META-ANALYSIS **Meta-analysis** is a type of study that, as its name implies, is an analysis of multiple analyses. In other words, it is a study of studies that have already been conducted. With meta-analysis, many studies that have addressed the same issue are combined and summarized in one "study of studies." The study we described that looked at 206 studies is an example of a meta-analysis.

Suppose that ten studies have been conducted on men's and women's effectiveness as leaders. Among these ten studies, five found no differences, two favored women, and three favored men. Researchers conducting a meta-analysis would not just count up the numbers of different findings from the research literature. Instead, they would weight more heavily those studies that had larger samples. Large samples are more likely to provide more accurate reflections of what is true in populations (see Figure 2.18). The researchers would also consider the size of each effect. That is, they would factor in whether each study found a large difference, a small difference, or no difference between the groups being compared—in this case, between women and men. (The researchers who conducted such a meta-analysis on men's and women's effectiveness found no overall differences; Eagly, Karau, & Makhijani, 1995.)

Because meta-analysis combines the results of separate studies, many researchers believe that meta-analysis provides stronger evidence than the results of any single study. As discussed earlier in this chapter, we can be more confident about results when the research findings are replicated. Meta-analysis has the concept of replication built into it.

inferential statistics
A set of assumptions and procedures used to evaluate the likelihood that an observed effect is present in the population from which the sample was drawn.

meta-analysis
A "study of studies" that combines the findings of multiple studies to arrive at a conclusion.

What to Believe? Using Psychological Reasoning

Misunderstanding Statistics: Should You Bet on a Hot Hand?

In 2013, the Miami Heat's LeBron James set a basketball record by scoring over 30 points, while making over 60 percent of his shots, for six straight games (**FIGURE 2.35**). In the seventh game, James's streak ended, when he scored on just under 60 percent of his shots.

When events in the world seem to happen in clusters, people develop explanations such as the hot hand to make sense of them.

Did James have a "hot hand" during this streak? Are there periods when particular athletes are relaxed, confident, and "in the zone" and play particularly well? Team members try to get the ball to a person who has made several shots in a row, because they think the person's hot hand will increase their chance of winning. Many sports journalists, coaches, athletes, and fans believe in some form of the phenomenon.

The psychologist Tom Gilovich and his colleagues (1985) conducted a series of studies on the hot hand, to assemble beliefs about the phenomenon and to scientifically examine whether it exists. Their first and crucial step was to turn the idea of the hot hand into a testable hypothesis: After a basketball shooter has made two or three shots in a row, that shooter will be more likely to make the next shot than after missing the last two or three shots. When the researchers asked 100 knowledgeable basketball fans, 91 agreed that this outcome was likely. If their belief were accurate, then an analysis of shooting records should show the increased probability of making a shot after previous successes than after previous failures.

To test whether the "hot hand" hypothesis is supported by evidence, Gilovich and colleagues examined the shooting records of the Philadelphia 76ers during the 1980–81 season. The 76ers kept records of the order that shots had been taken as well as the outcome of those shots. The data did not support the hot hand hypothesis. Players made on average 51 percent of their shots after making one previous shot, 50 percent after making two previous shots, and 46 percent after making three in a row. If anything, players were more likely to be successful after prior misses: 51 percent after one prior miss, 53 percent after two prior misses, and 56 percent after missing three in a row.

As a critical thinker, you might wonder whether the defensive team stops the streak by paying more attention to hot shooters and putting in more effort to defend against them. To test this alternative explanation, Gilovich and colleagues examined free throw shooting, where the defense does not matter and players get two free shots. Players made about the same number of second free throws whether they made the first one or not.

Upon hearing the results of this research, the famous coach Red Auerbach, of the Boston Celtics, exclaimed, "Who is this guy? So he makes a study. I couldn't care less" (Gilovich, 1991, p. 17). Any one study might be questionable until other scientists have replicated the findings. Indeed, the occasional study supports the idea of the hot hand for some sports, such as volleyball (Raab, Gula, & Gigerenzer, 2011). However, a meta-analysis of all studies that have examined this phenomenon enables us to consider all the outcomes at the same time. A meta-analysis of 22 published articles found no evidence that the hot hand exists (Avugos, Köppen, Czienskowski, Raab, & Bar-Eli, 2012). Athletes across various sports were no more likely to be successful after a prior success than after a prior failure.

Why do people believe in shooting streaks? The best answer is that people are bad at recognizing chance outcomes. If a fair coin is flipped, most people intuitively expect there to be a greater alternation of heads and tails than occurs by chance. If you flip a coin 20 times in a row, however, there will be streaks of six heads or tails in a row 10 percent of the time, five in a row 25 percent of the time, and four in a row 50 percent of the time. Players do occasionally sink the shot six, seven, or eight times in a row, but these occurrences do not happen any more often than what we expect from chance, given the number of shots they take in a game.

FIGURE 2.35 LeBron James
Did a "hot hand" help James during his six-game streak in 2013?

Summing Up

How Are Data Analyzed and Evaluated?

- Data must be valid, reliable, and accurate.
- Data should have construct validity (measure what they are supposed to measure), external validity (apply outside of the laboratory), and internal validity (accurately represent effects of manipulations to the independent variable and not something else).
- Descriptive statistics summarize data. They include measures of central tendency and measures of variability.
- Measures of central tendency—such as the mean, median, and mode—indicate the typical response of a group as a whole.
- Measures of variability, such as standard deviation, indicate how widely numbers are distributed about the mean or average score.
- A correlation coefficient describes the strength and nature of the relationship between two variables.
- Inferential statistics indicate whether the results of a study reflect a true difference between groups or are likely to be due to chance.
- Meta-analysis combines the results of several studies to arrive at a conclusion.

Measuring Up

1. **When researchers want to summarize in a single number all the data they collect, they compute a measure of central tendency. Here are hypothetical data for a study in which 10 people in a sample consumed alcohol. The researchers measured the number of glasses of alcohol each person consumed and assessed her or his motor control after consuming the alcohol. The scores on motor control ranged from 1 (poor motor control) to 10 (good motor control). Compute the mean, median, and mode for the amount of alcohol consumed and the ratings of motor control.**

Amount of alcohol consumed	Rating of motor control
3	4
1	9
5	1
2	7
3	5
3	3
1	8
4	2
5	1
2	6

2. **Which is an accurate description of the rationale for inferential statistics?**
   a. When the means of two sample groups are significantly different, we still need to compute a mean value for each population before we can conclude that the groups really are different.
   b. When the means of two sample groups are significantly different, we can be fairly certain that we did not make any mistakes in our research.
   c. When the means of two sample groups are significantly different, we can be certain that the data are not correlated.
   d. When the means of two sample groups are significantly different, we can infer that the differences between the two groups are unlikely to be due to chance.

ANSWERS: (1) Amount of alcohol consumed: mean = 2.9, median = 3, and mode = 3; rating of motor control: mean = 4.6, median = 4.5, and mode = 1. **(2) d.** When the means of two sample groups are significantly different, we can infer that the populations the groups were selected from are different.

Your Chapter Review

Chapter Summary

2.1 How Is the Scientific Method Used in Psychological Research?

- **Science Has Four Primary Goals:** The four primary goals of science are *description* (describing what a phenomenon is), *prediction* (predicting when a phenomenon might occur), *control* (controlling the conditions under which a phenomenon occurs), and *explanation* (explaining what causes a phenomenon to occur).
- **Critical Thinking Means Questioning and Evaluating Information:** Critical thinking is a skill that helps people become educated consumers of information. Critical thinkers question claims, seek definitions for the parts of the claims, and evaluate the claims by looking for well-supported evidence.
- **The Scientific Method Aids Critical Thinking:** Scientific inquiry relies on objective methods and empirical evidence to answer testable questions. The scientific method is based on the use of theories to generate hypotheses that can be tested by collecting objective data through research. After a theory has been formulated based on observing a phenomenon, the six steps of the scientific method are forming a hypothesis based on the theory, reviewing the scientific literature to see how people are testing the theory, choosing a research method to test the hypothesis, conducting the research study, analyzing the data, and disseminating the results.
- **Unexpected Findings Can Be Valuable:** Unexpected (serendipitous) discoveries sometimes occur, but only researchers who are prepared to recognize their importance will benefit from them. Although unexpected findings can suggest new theories, these findings must be replicated and elaborated.

2.2 What Types of Studies Are Used in Psychological Research?

- **Descriptive Research Consists of Case Studies, Observation, and Self-Report Methods:** Researchers observe and describe naturally occurring behaviors to provide a systematic and objective analysis. A case study, one kind of descriptive study, examines an individual or an organization. However, the findings of a case study may not generalize. Data collected by observation must be defined clearly and collected systematically. Bias may occur in the data because the participants are aware they are being observed or because of the observer's expectations. Surveys, questionnaires, and interviews can be used to directly ask people about their thoughts and behaviors. Self-report data may be biased by the respondents' desire to present themselves in a particular way (e.g., smart, honest).
- **Correlational Studies Describe and Predict How Variables Are Related:** Correlational studies are used to examine how variables are naturally related in the real world. These studies cannot be used to establish causality or the direction of a relationship (which variable caused changes in another variable).
- **The Experimental Method Controls and Explains:** Experiments can demonstrate causal relationship between variables. Experimenters manipulate one variable, the independent variable, to determine its effect on another, the dependent variable. Research participants are divided into experimental groups and control groups. The experimental groups experience the independent variable, and the control groups are used for comparison. In evaluating the data, researchers must look for confounds—elements, other than the variables, that may have affected the results.
- **Random Sampling and Random Assignment Are Important for Research:** Researchers sample participants from the population they want to study (e.g., drivers). They use random sampling when everyone in the population is equally likely to participate in the study, a condition that rarely occurs. To establish causality between an intervention and an outcome, random assignment must be used. When random assignment is used, all participants have an equal chance of being assigned to any level of the independent variable, and preexisting differences between the groups are controlled. Culturally sensitive research recognizes the differences among people from different cultural groups and from different language backgrounds.

2.3 What Are the Ethics Governing Psychological Research?

- **There Are Ethical Issues to Consider in Research with Human Participants:** Ethical research is governed by principles that ensure fair, safe, and informed treatment of participants. Institutional review boards (IRBs) judge study proposals to make sure the studies will be ethically sound.
- **There Are Ethical Issues to Consider in Research with Animals:** Research involving nonhuman animals provides useful, although simpler, models of behavior and of genetics. The purpose of such research may be to learn about animals' behavior or to make inferences about human behavior. Institutional Animal Care and Use Committee (IACUC) judges study proposals to make sure the animals will be treated properly. Researchers must weigh their concerns for individual animals against their concerns for humanity's future.

2.4 How Are Data Analyzed and Evaluated?

- **Good Research Requires Valid, Reliable, and Accurate Data:** Data must be meaningful (valid) and their measurement reliable (i.e., consistent and stable) and accurate.
- **Descriptive Statistics Provide a Summary of the Data:** Measures of central tendency (mean, median, and mode) and variability are used to describe data.
- **Correlations Describe the Relationships Between Variables:** A correlation coefficient is a descriptive statistic that describes the strength and direction of the relationship between two variables. Correlations close to zero signify weak relationships. Correlations near +1.0 or −1.0 signify strong relationships.
- **Inferential Statistics Permit Generalizations:** Inferential statistics allow us to decide whether differences between two or more groups are probably just chance variations (suggesting that the populations the groups were drawn from are the same) or whether they reflect true differences in the populations being compared. Meta-analysis combines the results of several studies to arrive at a conclusion.

Key Terms

accuracy, p. 65
case study, p. 44
central tendency, p. 65
confound, p. 53
construct validity, p. 63
control group, p. 52
correlation coefficient, p. 67
correlational studies, p. 48
culturally sensitive research, p. 56
data, p. 34
dependent variable, p. 43
descriptive research, p. 44
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variable, p. 43
zero correlation, p. 49

Practice Test

1. Which of the following is a technique that increases scientists' confidence in the findings from a given research study?
- **a.** meta-analysis
- **b.** operationalization of variables
- **c.** replication
- **d.** serendipity

For the following four questions, imagine you are designing a study to investigate whether deep breathing causes students to feel less stressed. Because you are investigating a causal question, you will need to employ experimental research. For each step in the design process, indicate the most scientifically sound decision.

2. Which hypothesis is stronger? Why?
- **a.** Stress levels will differ between students who engage in deep breathing and those who do not.
- **b.** Students who engage in deep breathing will report less stress than those who do not engage in deep breathing.

3. Which sampling method is strongest? Why?
- **a.** Obtain an alphabetical list of all students enrolled at the college. Invite every fifth person on the list to participate in the study.
- **b.** Post a note to your Facebook page letting friends know you would like their help with the study. Ask your friends to let their friends know about the study, too.
- **c.** Post fliers around local gyms and yoga studios inviting people to participate in your study.

4. Which set of conditions should be included in the study? Why?
- **a.** All participants should be given written directions for a deep-breathing exercise.
- **b.** Some participants should be given written directions for a deep-breathing exercise. Other participants should be given a DVD with demonstrations of deep-breathing exercises.
- **c.** Some participants should be given written directions for a deep-breathing exercise. Other participants should be given no instructions regarding their breathing.

5. How should participants be chosen for each condition? Why?
- **a.** Once people agree to participate in the study, flip a coin to decide if each will be in the experimental condition or the control condition.
- **b.** Let participants select which condition they would like to be in.

The answer key for the Practice Tests can be found at the back of the book.