Module 3 Research Strategies

Learning Goals

3-1 Identify the advantage research has over other ways of knowing things.

3-2 Describe ways that bias can influence research.

3-3 Explain why psychological scientists use case studies.

3-4 Explain why you can't conclude that a correlation represents a cause-and-effect relationship.

3-5 Explain why we should be cautious about data from surveys.

3-6 Describe why longitudinal and cross-sectional studies are used.

3-7 Explain how experiments are designed and why this makes experiments the most powerful research technique.

3-8 Describe the ethical guidelines that protect human and animal research participants.

Psychological scientists use a variety of tools, methods, and research subjects to learn about behavior and mental processes.

How do you know what you know? You can know something because a friend told you or because you read it. You can also know something because it "seems obvious"—in other words, through common sense. These and many other ways of knowing may be right. But they may also be wrong. Psychologists use the **scientific method,** a method of learning about the world through the application of critical thinking and tools such as observation, experimentation, and statistical analysis. Psychologists rely on the scientific method because it is more likely than other methods to answer certain kinds of questions correctly. In this module, we explore some research tools available to scientists seeking knowledge. It is because psychologists use these tools that psychology is considered a science.

scientific method A method of learning about the world through the application of critical thinking and tools such as observation, experimentation, and statistical analysis.

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The Scientific Method at Work
What do these individuals have in common? They are researchers who rely on the scientific method to learn about their chosen area of study. By using the tools of science and critical thinking, they can help us understand how the world operates.

Why Is Research Important?

3-1 What advantage does research have over other ways of knowing things?

Many students sign up for their first psychology class hoping to cover the stuff associated with psychology that they've seen on TV and the Internet. How do I analyze my dreams? What makes me (and others) tick? Does my friend have an eating disorder? Too often, the "answers" we find in the media are more myth than reality. Psychological scientists use research tools and critical thinking to find correct answers to these questions.

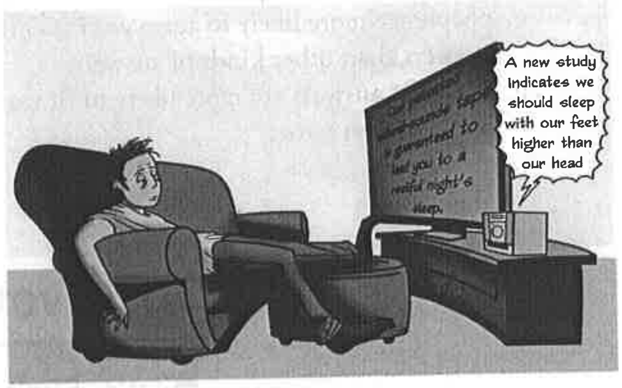
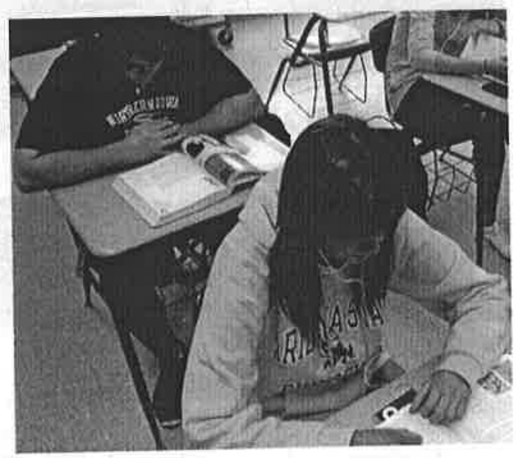


FIGURE 3.1
How Do You Know What to Believe?
Critical thinking and knowledge of research help us evaluate competing claims.

Even if you don't believe you're interested in research, give it a chance. Do you like solving problems and figuring out the answers to puzzles? If so, research should be right up your alley. Research is not just a series of experiments and it doesn't always involve fancy lab equipment. It's a set of methods, a way of asking questions about the world and drawing logical, supported conclusions. These are important life skills for everyone. Headlines trumpet the latest findings about caffeine, and news anchors are forever introducing segments on new ways to treat depression and on how the brain works. If you don't know enough about research to decide when conclusions are reasonable and when they are not, you leave yourself at the mercy of the media. (See **Figure 3.1** for an example of how the media might bombard us with contradictory claims.) We surely won't all conduct research, but we will all be called on to evaluate its relevance. Just as modern civilization requires people to be computer literate to function well, it requires people to be research literate to make informed decisions.

In this module, we will see how psychologists conduct research by considering an example. Suppose your school is about to institute a new policy banning the use of earbuds and earphones to listen to music in study halls. How might we predict the effect of this new policy?



Charles Blair-Broeker

Listen Up!
Does listening to your earbuds affect studying? Science can provide answers to questions like this.

One way is to use common sense. Perhaps the common sense of school administrators told them that students can concentrate better if they are not distracted by music. But wait! *Your* common sense might lead you to the opposite conclusion. Maybe you feel that the music allows you to block out distracting noises and focus more effectively on your homework. That's the trouble with common sense; too often, it can lead you to whatever conclusion you want (see **Table 3.1**). Scientific methods that psychologists use can help you evaluate the competing hunches.

TABLE 3.1 The Limits of Common Sense

Common sense leaves us unsure of the truth, but research helps us apply principles appropriately in different situations.

Common sense says . . .		
Opposites attract	but	Birds of a feather flock together
Out of sight, out of mind	but	Absence makes the heart grow fonder
Nothing ventured, nothing gained	but	A penny saved is a penny earned

MAKE IT STICK!

1. One advantage of the scientific method over other ways of understanding the world is that

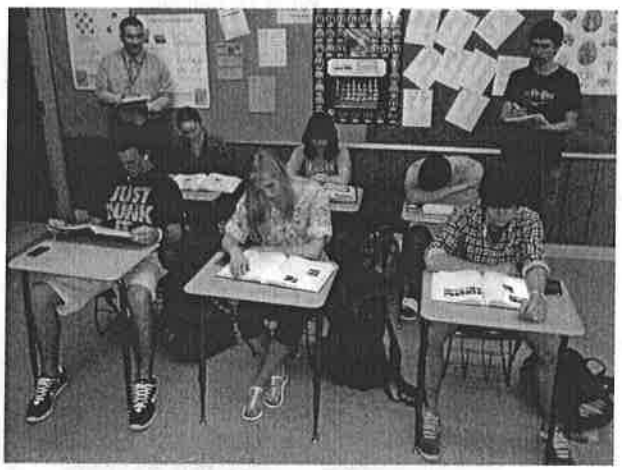
a. the scientific method can answer any question.
b. the scientific method leads to more reliable, reproducible answers.
c. people are more likely to agree with scientific answers than other kinds of answers.
d. scientific answers are more likely to fit with our common sense.

2. Briefly describe why it is important for all people to have an understanding of the scientific method.

3. True or false? We should be skeptical of all claims made in the media.

Observation and Bias

3-2 What are some ways that bias can influence research?



Charles Blair-Broeker

Confirmation Bias Some students are studying and some aren't. Both the administrator and student tend to notice examples that support their own points of view.

The simplest scientific technique is *observation*. In our example, you might watch students using earbuds and compare them with students not using earbuds. Which students look more focused and more intent on their work?

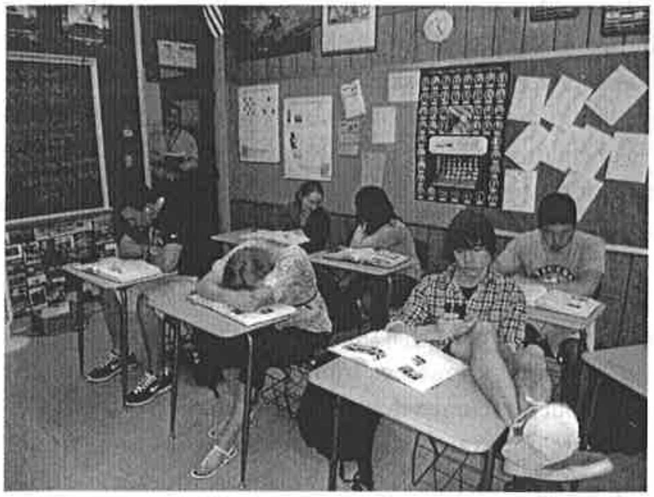
Observation, however, presents a problem: the potential for bias. The most common bias on the part of the researcher is called **confirmation bias,** a tendency to search for information that agrees with a preconception. As you might imagine, researchers try to avoid bias as they would the plague. In our example, you and an administrator might observe the same students listening to music while studying and come to opposite conclusions. You want the research to demonstrate that music is helpful, so you may be especially sensitive to behaviors that support this conclusion. An administrator may miss the behaviors you notice and may instead pay closer attention to actions that seem to indicate music is distracting. Both you and the administrator are being influenced by your biases.

There are many ways to reduce confirmation bias, and the best method depends on the particular study. In our example, we might try to make the observations more *objective* (that is, less biased) by finding ways to rely less on the observer's opinion. For example, we could compare the grades of students who listen to music while studying with the grades of students who don't. Or perhaps we could have the observers count specific behaviors, like how many times in a 10-minute period students look away from their work or how many pages students read in 10 minutes. If you're thinking these methods could have flaws as well (just because students are turning pages does not mean they are learning anything), congratulations! You're using **critical thinking.** Psychologists use critical thinking to examine assumptions, uncover hidden values, evaluate evidence, and assess conclusions.

The point is that there is no perfect way to eliminate bias. The goal of psychological research is to minimize bias and maximize the probability of obtaining a reliable, meaningful conclusion.

confirmation bias The tendency to focus on information that supports preconceptions.

critical thinking Thinking that does not blindly accept arguments and conclusions.



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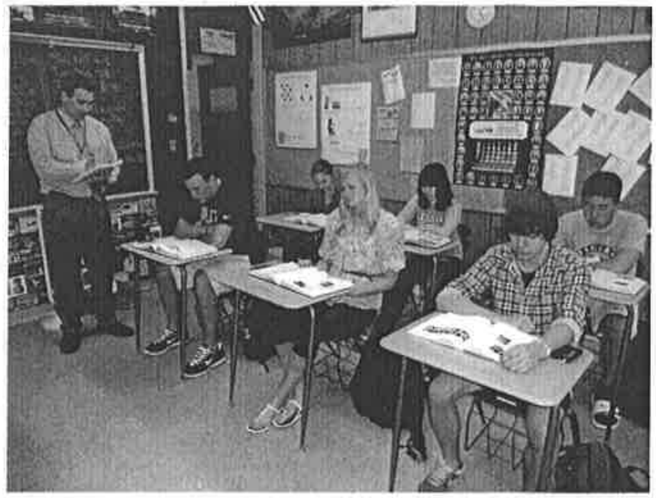


Charles Blair-Broeker

Naturalistic Observation Under which circumstances do you think the principal's observations are more accurate? Naturalistic observation requires that the behavior not be unduly influenced by the observer. Can you see that this might sometimes produce ethical concerns?

Researchers must also watch for **participant bias,** a tendency for research participants to behave in a certain way because they know they are being observed or because they want to please the researcher. For example, the students might study harder because the administrator is in the room, which might lead the administrator to conclude that they are studying more effectively because they are not distracted by music. To minimize participant bias, psychologists often use **naturalistic observation,** observing and recording behaviors without manipulating or controlling the situation. To avoid influencing participants' behavior simply because of their presence, observers in a lab setting may use hidden cameras or one-way mirrors. Now, researchers have begun to observe by mining "big data"; that is, what we search for on Google and what we tweet, among other Internet sources, can provide important clues about what the public is thinking and feeling.

participant bias A tendency for research participants to behave in a certain way because they know they are being observed or they believe they know what the researcher wants.

naturalistic observation Observing and recording behavior in naturally occurring situations without manipulating or controlling the situation.

MAKE IT STICK!

1. ______ bias exists when researchers only look for information that supports their point of view.
2. One way to minimize participant bias is to use ______ observation to collect data.
3. True or false? Critical thinking means finding ways to criticize someone's position.

Case Studies

3-3 Why do psychologists use case studies?

In the previous section, we looked at observation and bias. Now we turn our attention to a specific technique that relies on observational skills. Researchers who study single individuals in depth in the hope of revealing universal principles are using the **case study** method. Keep in mind that the case study method is prone to bias, and it may not be possible to extend the results of one case study to other people or situations. For example, an in-depth study of just one earbud-using

case study A research technique in which one person is studied in depth in the hope of revealing universal principles.

student in study hall could provide some very unrepresentative results because that particular student could naturally be exceptionally focused or distractible.

Sometimes, however, a case study is all that is ethically possible. Child abuse, for example, is often researched with case studies. Obviously, it would be unethical for researchers to abuse a sample of children, so they must wait until authorities discover a case of abuse and then attempt to study the effects of that abuse. "Genie" was the subject of just such a study. She was discovered in California in 1970, a 13-year-old victim who had spent her life in such isolation that she had not even learned to speak. Since 1970, psychologists have intensively studied Genie's behavior and progress to learn about the development of language and social skills. Researchers who study cases such as Genie's hope to glean important knowledge from these tragic situations that can help explain general truths about human development and behavior.

Because no two cases of abuse are exactly alike, there is always some doubt about the conclusions of any one case study. But as similar case studies accumulate, researchers gain increasing confidence in the accuracy of their conclusions.

MAKE IT STICK!

1. A researcher would use a ______ to learn about a unique situation, such as a child growing up in a household in which four languages are spoken.
2. Why must researchers be cautious about the results of a case study?

Correlation

3-4 Why is it impossible to conclude cause-and-effect relationships from correlational data?

correlational study A research project strategy that investigates the degree to which two variables are related to each other.

LIFE MATTERS

When you see headlines that make claims such as "Science proves..." or makes statements, like "Cell Phones Cause Depression," what keywords should you look for to determine if these are correlational studies? "Prove" and "cause" have specific meanings in science - that the results were obtained using experimental methods, not correlational.

Another technique available to researchers is to collect and examine correlational data. Is there a relationship between diet and health? Between communication style and divorce? Between training techniques and success at the Olympics? To answer these kinds of questions, researchers use a **correlational study,** a research project designed to discover the degree to which two variables are related to each other. In the question about use of earbuds during studying, there are two variables:

1. Whether or not a student listens to music
2. Effectiveness of studying

If effectiveness of studying increases when students listen to music and decreases when students do not, then we can say that the two variables are *positively correlated.* That is, the two variables increase (or decrease) together. But if effectiveness of studying decreases when students listen and increases when they do not, then the variables are *negatively correlated*—one variable increases while the other decreases (see **Figure 3.2**).

Remember, the discovery of a correlation *does not prove that a cause-and-effect relationship exists.* Results from correlational studies can tell us that two variables are related, but not *why* they are related. Suppose a researcher discovered a negative correlation between TV watching and grade point average (GPA): Students who watched more television had lower GPAs. Based on this correlation alone, can we conclude that TV watching *causes* grades to suffer? The answer is *no.* It is indeed

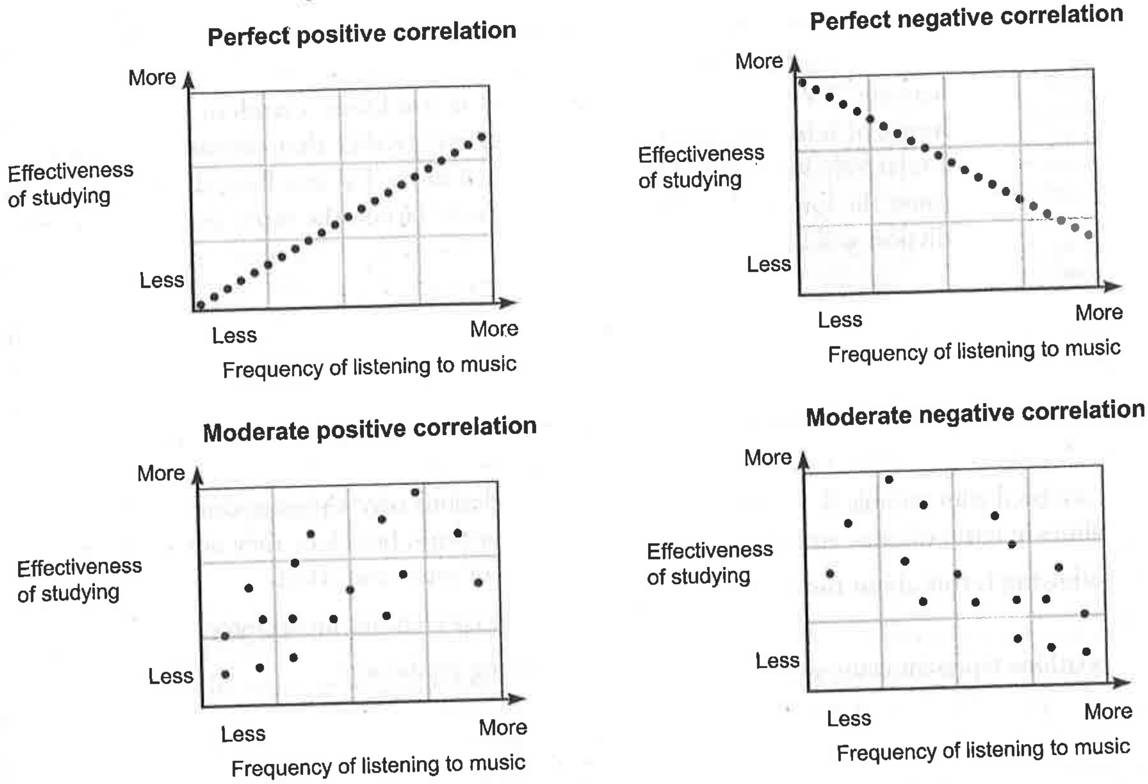


FIGURE 3.2
Positive and Negative Correlations
Correlations can be easily visualized with these scatterplots. Each red dot represents one student. Dots that are higher on the plot indicate more effective studying. Dots that are farther right indicate more time listening to music.

The two top graphs show what perfect positive and negative correlations would look like for listening to music and effectiveness of studying. In the positive correlation, as music use increases, so does effectiveness of studying. In the negative correlation, effectiveness of studying decreases as music use increases. Actual data would surely look more like one of the two bottom graphs, which show moderate positive and negative correlations.

possible that watching television causes one's grades to decline, but there are other possible explanations as well. It may be that having low grades causes one to watch more TV. There could even be some other variable—say, low intelligence—that could cause both a lot of TV watching and low grades. Correlation does not tell us which of these explanations is correct (see **Figure 3.3**).

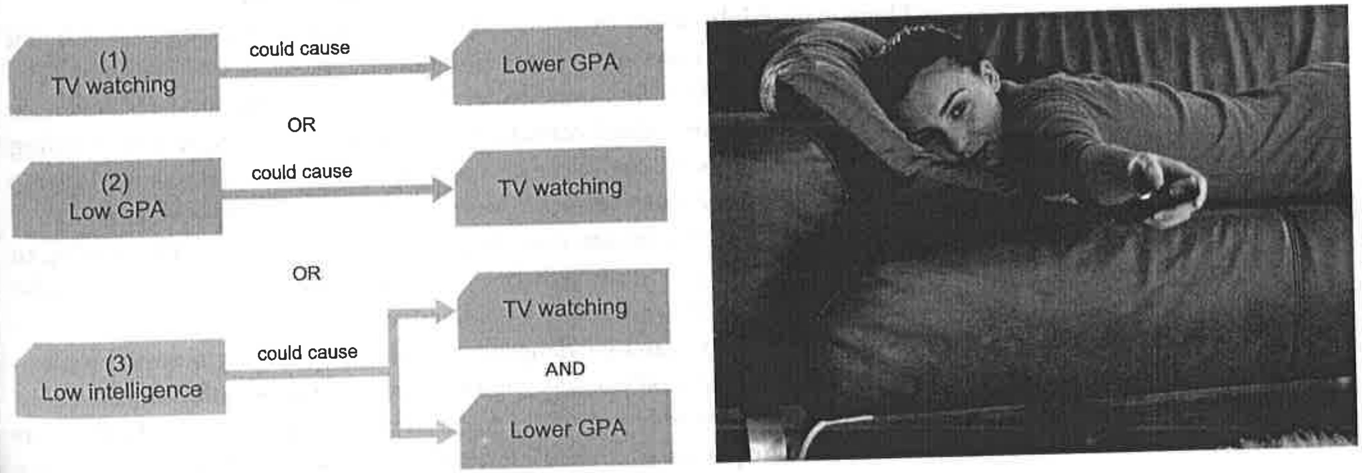


FIGURE 3.3
Correlation Is Not Causation
The discovery of a negative correlation between TV watching and grade point average (GPA) would not provide any information about what caused the correlation. Here are three equally plausible explanations.

Correlations cannot establish cause-and-effect relationships, but they are useful for making predictions. If you know there is a strong negative correlation between TV watching and grades, and if you know a student watches several hours of television each day, then you can predict that the student will have a relatively low GPA. This is true even if more TV watching does not directly cause the low grades. The stronger the correlation, the more accurate your prediction will be.

MAKE IT STICK!

1. A ______ correlation exists when one variable increases while another variable decreases.
2. If variable A is correlated with variable B, what are the three possibilities in terms of cause and effect?
3. Which of the following is true about the nature of correlations?
   a. Positive correlations represent cause-and-effect relationships, but negative correlations do not.
   b. Negative correlations represent cause-and-effect relationships, but positive correlations do not.
   c. All correlations represent cause-and-effect relationships.
   d. Correlations may represent cause-and-effect relationships, but alone they don't provide proof of cause and effect.
4. What are correlations useful for?
   a. Making predictions
   b. Eliminating bias
   c. In-depth studies of individuals
   d. Establishing cause and effect

Surveys

3-5 Why should we be cautious when applying data obtained from surveys?

survey method A research technique that questions a sample of people to collect information about their attitudes or behaviors.

How do researchers go about collecting data to establish a correlation? One way is to use the **survey method,** a research technique that questions a sample of people to collect information about their attitudes or behaviors. In the music example, you might have students fill out a short questionnaire about the effect of earbud use in study hall. Surveys allow researchers to collect large amounts of data efficiently through the use of such questionnaires and interviews.

There is no doubt about the efficiency of surveys or about the value of being able to collect data from large numbers of people relatively inexpensively. The problem is that surveys are almost seductively efficient. It seems so simple to create a survey that people often don't consider how easily bias can influence the wording of the questions. Do you like flowers?, for example, will not get the same response as, Do you like horticulture? Surveys also raise the problem of *social desirability.* For example, a student may say that she can study effectively while listening to music even though she doesn't really believe it. She answers that way because she thinks that's how others would want her to answer.

population The entire group of people about whom you would like to know something.

random sample A sample that fairly represents a population because each member of the population has an equal chance of being included.

But assume you have carefully designed your survey questions to avoid bias. You still must be sure your survey results will be relevant to the **population,** the entire group of people about which you would like to know something. To do this, you must draw an adequately sized **random sample,** a sample that fairly represents a population because each member of the population has an equal chance of being included (see **Figure 3.4**).

FIGURE 3.4
Sample and Population
The larger jar contains a population—in this case, a mixture of two colors of marbles. You can efficiently learn the percentage of each color in this larger group of marbles by randomly removing a sample (represented by the marbles in the smaller jar) and counting the two colors.

If the population you wish to study is the students in study halls at your school, you could, for example, draw a random sample by selecting every tenth name from a list of students registered for study halls. But is this number adequate? Researchers answer that question with mathematical formulas, but in general, larger samples are better—if they are random. If the sample is not random, it might have a larger percentage of good (or bad, or sick, or sassy) students than the whole study hall population does. This makes the sample biased and therefore not a good way to draw conclusions about the study hall population.

MAKE IT STICK!

1. What is the most important caution you would give to a researcher interested in using a survey?
2. To be useful, a survey must be administered to a ______ sample pulled from a larger representative ______.
3. True or false? In a random sample, each member of the population has an equal chance of being included.

Longitudinal and Cross-Sectional Studies

3-6 Why do psychologists conduct longitudinal and cross-sectional studies?

How much do you think you will change in the next 20 years? Will you have the same personality traits, for example? Be interested in the same things you are now? Longitudinal and cross-sectional studies are techniques of particular use to developmental psychologists, who study how individuals change throughout the life span. **Longitudinal studies** follow the same group of individuals over a long time. In the 1920s, psychologist Lewis Terman began a famous longitudinal study of a group of highly intelligent California children. He, and later other researchers, studied these individuals for 70 years to discover what happens to bright children as they grow up. The researchers learned that in general, these gifted people had successful careers.[1] Longitudinal studies provide a rich source of data as time passes, but they are quite expensive and difficult to conduct. As a result, they tend to be pretty rare. Imagine the challenges of keeping track of a group of study hall students throughout their lifetime to determine the long-term effects of listening to (or not listening to) music with earbuds.

It is more common to conduct **cross-sectional studies,** which compare people of different ages at one time. A psychologist interested in how memory changes over the life span could gather a random sample of people from different age

longitudinal study A research technique that follows the same group of individuals over a long period.

cross-sectional study A research technique that compares individuals from different age groups at one time.

groups and administer a memory test to all of them. Cross-sectional studies are more efficient than longitudinal studies, but they have their own problems. If the test showed that the older groups had less memory ability than the younger groups, that *could* mean that memory declines as people age. But this difference could also be explained by other factors, such as changes over time in the educational system or the introduction of computers (or earbuds).

MAKE IT STICK!

1. _____ studies compare individuals from different age groups at one time.
2. Why are more cross-sectional studies conducted than longitudinal studies?

Experiments

3-7 Why are experiments the most powerful research technique of all, and what factors contribute to the design of an experiment?

experiment A research method in which the researcher manipulates and controls certain variables to observe the effect on other variables.

Observation, case studies, correlational studies, surveys, longitudinal studies, and cross-sectional studies are all important research techniques. Psychologists often use these different techniques in combination—for example, by using naturalistic observations to do a case study or by conducting surveys to establish correlations. But for establishing *cause and effect,* there is only one game in town, and researchers prefer it above all others. The **experiment** is the *only* method that allows us to draw conclusions about cause-and-effect relationships. Because experiments require researchers to control the things that can change—the variables—in a study, the chances of isolating the variable causing a particular effect are much greater.

Let's design an experiment to find out if banning listening to music in study halls would affect grades.

Hypotheses and Operational Definitions

hypothesis A testable prediction about the outcome of research.

operational definition An explanation of the exact procedures used to make a variable specific and measurable for research purposes.

In designing our experiment, the first thing we do is generate a **hypothesis**—a testable prediction about the outcome of research. Researchers often start with general expectations (Music influences concentration in study halls), but then put their variables in a more specific form that allows them to be precisely measured. In the language of research, they provide **operational definitions** of the variables—explanations of the exact procedures used to define research variables. One way to operationalize our hypothesis is to put it in this form: *Students assigned to listen to music each day in study hall will have higher average grades at the end of the term than students banned from listening to music.* We could operationalize the hypothesis in many other ways. We could say, *Students who are banned from listening to music each day in study hall will read fewer pages each day than students who are not banned from listening to music,* or *Students who use earbuds each day in study hall will have fewer conversations with other students in study hall than students who are not allowed to use earbuds.* Each of these versions has slightly different implications. Researchers must settle on the one operational definition that they believe does the best job of accurately reflecting the general hypothesis.

This is an important point even if you never conduct an experiment of your own. When you are evaluating research done by others, you should consider whether the operational definitions are appropriate or inappropriate. For example, every year *U.S. News and World Report* publishes rankings of the best colleges and universities in the United States. But how do the researchers operationalize *best?* The material that accompanies the rankings tells you they use a complex formula that considers factors like first-year retention rate, financial support for students, and undergraduate reputation. If you don't agree with the weightings in the formula (maybe you're much more concerned about financial support than they are or much less concerned with reputation), then you shouldn't put much faith in the rankings.

Operational Definitions and Positive Psychology

Positive psychologists have research problems similar to those faced by all scientists. One of them is to develop adequate operational definitions. Like many things, this is often more difficult than it appears.

For example, positive psychologists are interested in happiness. They recognize that it's not exactly the opposite of, or even the absence of, depression. So, what is it? And more important, how do you measure it for research purposes? There are many ideas about how to do this, and none of them are perfect.

- Perhaps you could measure happiness with some physiological measure. Wouldn't it be nice if it were as easy to measure happiness as it is to measure blood pressure or cholesterol level? *Yes,* it would be nice, but so far we haven't been able to discover a direct physiological measure.
- Maybe you could measure happiness using observation. One way to do this would be to look for evidence that a person is smiling. However, people don't always agree about what a smile is—another problem with the operational definition! Smiles aren't always genuine, either, and it's also possible to be happy without smiling (or to smile without being happy).
- Another way to measure happiness would be to administer surveys, and survey results, in fact, are often used as the operational definition of happiness. One such survey is the Satisfaction With Life Scale, seen in **Figure 3.5**.[2] Why don't you give it a try!

Directions: Below are five statements with which you may agree or disagree. Using the 1–7 scale below, indicate your agreement with each item by placing the appropriate number in the line preceding that item. Please be open and honest in your responding.

1 = strongly disagree
2 = disagree
3 = slightly disagree
4 = neither agree nor disagree
5 = slightly agree
6 = agree
7 = strongly agree

_____ 1. In most ways my life is close to my ideal.
_____ 2. The conditions of my life are excellent.
_____ 3. I am satisfied with my life.
_____ 4. So far I have gotten the important things I want in life.
_____ 5. If I could live my life over, I would change almost nothing.

Source: Diener et al. (1985).

FIGURE 3.5 Satisfaction With Life Scale

Scores on this Satisfaction With Life Scale can range from 5 to 35, with scores above 20 generally indicating satisfaction with life. Does your overall score seem accurate? Does it match your impression of what it means to be happy? If so, that means you believe that scores on this survey are a good operational definition of happiness.

Independent and Dependent Variables

Back to our experiment. Let's assume we have agreed on this hypothesis: *Students assigned to listen to music each day in study hall will have higher average grades at the end of the term than students banned from listening.* To discuss this hypothesis, you should know a little more about how variables are labeled. Trying to discuss experiments without knowing the different names for variables is like trying to discuss skateboarding without knowing the names of the tricks. It may be possible to describe a kickflip backside tailslide without knowing the phrase, but it sure is difficult.

You already know that the purpose of an experiment is to establish a cause-and-effect relationship (in our case, finding out whether listening to music causes student grades to go up). Every hypothesis for an experiment reflects this cause-and-effect pattern, and when you read a hypothesis, you should be able to identify two variables, the independent variable and the dependent variable:

- The variable that should cause something to happen is the **independent variable (IV).**
- The variable that should show the effect (or the outcome) of changing the IV is the **dependent variable (DV).**

independent variable (IV) The variable that the researcher will actively manipulate and, if the hypothesis is correct, that will cause a change in the dependent variable.

dependent variable (DV) The variable that should show the effect of the independent variable.

Whenever you think about an experiment, a good first step is to identify the IV and the DV. If you are unable to figure this out, you will almost certainly not understand the point of the experiment.

So, what is the IV—the cause variable—for our example? In our hypothesis, the variable that we predict will make a difference—our IV—is the presence or absence of music. The DV, or the variable that shows the effect, is the participants' average end-of-term grades.

Groups, Random Assignment, and Confounding Variables

To make the independent variable vary (take on different values), researchers set up groups of participants. Typical experiments have at least two groups: an experimental group and a control group (sometimes referred to as the experimental and control conditions). In the **experimental group,** the participants are exposed to the treatment (the IV). In the **control group,** the participants are not exposed to the treatment (the IV). Control group participants function as a comparison for the experimental group participants. In our example, the experimental group will comprise all students assigned to listen to music, and the control group will comprise all students who are not allowed to listen. These two groups will permit us to compare the effect of music on two groups of similar students.

experimental group The participants in an experiment who are exposed to the independent variable.

control group The participants in an experiment who are not exposed to the independent variable.

The number of participants assigned to each group depends on some complicated statistical factors, but usually there are at least 20 participants per group. Therefore, we need to select 40 students for the experiment. We need to draw these students randomly from the entire population of 400 study hall students (for example, by selecting every tenth name from a complete list of study hall students). If the selection is not random, the sample may be biased, and we would not be able to apply the results to the whole study hall population.

Now comes one of the most important steps: How do we decide which 20 students in the pool of participants should be in the experimental group and which 20 should be in the control group? An absolutely critical feature of experimental design is that the participants are placed in groups by **random assignment.** Because chance alone determines group assignment, we can assume individual differences among participants (for example, how well they sleep or how smart they are) will be equally distributed between the two groups. You could use a computer program to do the random assignment or a low-tech method like drawing names out of a hat. **Figure 3.6** summarizes the various components of our design.

random assignment A procedure for creating groups that allows the researcher to control for individual differences among research participants.

confounding variable In an experiment, a variable other than the independent variable that could produce a change in the dependent variable.

Individual differences among participants like health, attitude, and sleep quality are the largest category of a special kind of variable known as **confounding variables** (from a Latin word that means *to confuse*). These are variables other than the IV that could produce a change in the DV. To draw cause-and-effect conclusions from an experiment, researchers must adequately control for confounding variables. To see how this works, imagine for a moment that we didn't randomly assign the students to groups and those in the experimental group (the ones who listen to music) are also healthier than the students in the control group (those banned from music). If the experimental group does have higher average grades at the end of the term, how would we know what caused this? The cause could have been the IV—music—but it could also have been that a higher level of health in the experimental group allowed them to study more effectively. We really don't know because the health variable *confounds* the music variable.

We have to be careful about how we set up the two groups so that we can eliminate confounding variables that could influence our experimental group's performance. Potential confounding variables include the amount of sleep participants get, the number of personal problems they're experiencing, and the quality of the

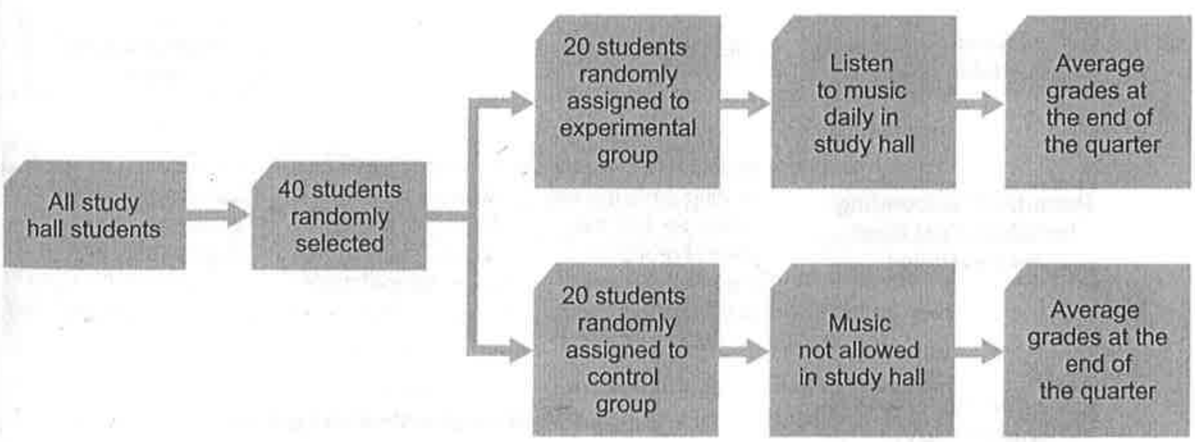


FIGURE 3.6
Experimental Design
The hypothesis is that students who are assigned to listen to music in study hall will have higher average grades at the end of the term than students banned from listening to music. To create different levels of the IV, the presence or absence of music, 40 randomly sampled students will be randomly assigned to an experimental group that listens to music and a control group that does not. Later we will determine the effect of this manipulation by measuring the DV, average grades at the end of the term, for each group. The hypothesis leads us to predict that the experimental group will have higher average grades.

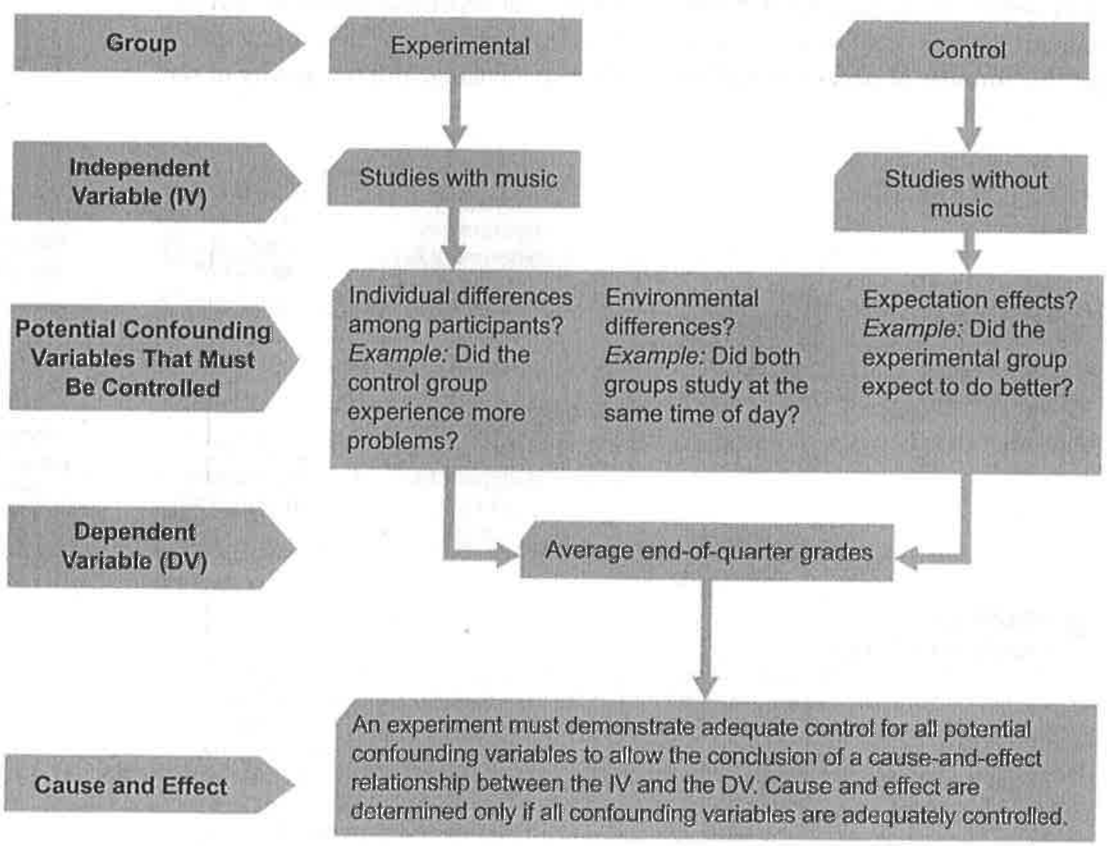
teachers they have. This is why random assignment of participants to groups is so critical: It enables the researcher to assume that these potentially confounding factors will balance almost evenly across the two groups, just as 40 coin flips will usually balance fairly evenly between heads and tails. (Go ahead. Try it!) Without random assignment, there is a much greater likelihood that a confounding variable will bias the results of the research. You have to randomly assign participants to groups to conduct a true experiment and identify the cause-and-effect relationship between the IV and the DV.

Control for Other Confounding Variables

In addition to controlling for individual differences, a good experimental design must control for two other types of confounding variables: environmental differences and expectation effects (see **Figure 3.7**). It is relatively easy to control for environmental differences. In our music example, you would want to make sure that all participants were in a study hall with the same temperature, lighting, and noise conditions.

Researchers must take special care, however, to control for expectation effects. They begin by making sure that participants are not aware of the hypothesis of the experiment. If participants were aware, then their expectations could influence the outcome. In our example, students in the experimental group might do better because their knowledge of the hypothesis led them to expect better grades and raised their confidence when taking tests. To control for expectation effects, experimenters often use a *blind* (or masked)

FIGURE 3.7
The Challenge of Confounding Variables
Experimenters use a variety of techniques to minimize the disruptive effects of confounding variables. There are two challenges involved: anticipating what the confounding variables will be, and then deciding on the best method of dealing with each of them.



procedure, which means that they do not tell participants what the hypothesis is until after the data are collected. Sometimes researchers use a **double-blind procedure,** in which neither the data collectors nor the research participants know the expected outcome of the experiment. Using a double-blind procedure is particularly important when the researchers collecting data are asked to make judgments about the dependent variable (for example, judging whether or not students are studying effectively). Without the double-blind procedure, researchers might be inclined to see what they expected to see and not see what they didn't expect. After the experiment, of course, the research participants are told the hypothesis.

double-blind procedure A research procedure in which both the data collectors and the research participants do not know the expected outcome of the experiment.

placebo An inactive substance or condition used to control for confounding variables.

If a drug is the independent variable, researchers deal with expectation effects by using a **placebo,** an inactive pill that has no known effect. Imagine that you want to test the effectiveness of a new drug that may enhance memory. To set up this experiment, you would form an experimental group and a control group to manipulate whether participants would receive the drug, the IV. You would measure the effect of the drug by comparing the two groups' performance on, say, a memory task, the DV. However, if the experimental group receives a pill and the control group does not, you will not be able to successfully interpret better performance by the experimental group. Why? Because our expectations have a profound and well-documented effect on our responses. People receiving a pill of any sort will expect to experience change, and they will work harder to achieve the expected results. Given this extra effort, you would not know whether the drug caused the enhanced memory in the experimental group or whether the expectations created by taking that drug enhanced people's memory.[3] You could control for this, however, by giving a placebo pill, containing no active substances, to the control group. Now, because all participants in both groups receive a pill and neither group knows whether the pill contains active or inactive substances, you can be sure that the expectations produced by taking a pill did not account for any improvement in memory.

Let's return to our music example and review what we've accomplished so far. We are conducting an experiment to test this hypothesis: *Students assigned to listen to music each day in study hall will have higher average grades at the end of the term than students banned from listening.* We have identified the independent variable as the presence or absence of music and are studying this variable by establishing an experimental group that does listen to music and a control group that doesn't. We have randomly selected the participants for the experiment from the entire study hall population, so we can be sure that the sample is not biased and the results will apply to all study hall students. We then randomly assigned the participants to the two groups to control for any individual differences among them, and we controlled for other confounding variables by making sure the environmental conditions and expectation effects for the two groups are as similar as possible. The only thing we want to differ between the two groups is the IV—whether or not students listen to music—because we want to be able to conclude that there is a cause-and-effect relationship between listening to music and having higher end-of-term grades.

Data Analysis

Now we run the experiment and collect the data. Then we analyze the numbers, using statistics, to find out if the hypothesis is supported.

Let's say the average end-of-term grade for the experimental group is a B and for the control group is a C. Is this enough of a difference to conclude that there is a cause-and-effect relationship between listening to music (or not) and grades? *Maybe.* But what if the difference was between a B and a B minus? How different must the values of the dependent variable be for the two groups? Perhaps you've heard the phrase *statistically significant.* Most researchers have agreed that we can consider a result statistically significant if the possibility that the difference between groups would occur by chance alone is no more than 5 percent. To determine this likelihood, statistical formulas consider three questions:

1. How big is the difference *between* the groups?
2. How similar are the results *within* each group?
3. How many participants are in each group?

If we find a big difference *between* two large groups of students and small variations in results *within* each group (for example, mostly As and Bs in one group and mostly Cs and Ds in the other), we can be confident that the results are statistically significant.

The steps of the experimental method are summarized for you in **Table 3.2**.

TABLE 3.2 The Experimental Method Step by Step

1. Develop the *hypothesis.*
2. Create *operational definitions* for the *independent variable (IV) and dependent variable (DV).*
3. *Randomly select* a sample of participants from the population.
4. *Randomly assign* the participants to the *experimental and control groups.*
5. Expose the experimental group, but not the control group, to the IV. If necessary, use a *placebo* with the control group to balance expectations.
6. Control for other *confounding variables* by using a *doubleblind procedure* and treating both groups the same except for exposure to the IV.
7. Learn the effect of the IV by measuring the DV for both groups.
8. Use *statistical analysis* to discover whether the difference in the DV between the two groups is likely to have been caused by the manipulation of the IV.

Replication

replicate To repeat the essence of a research study to see whether the results can be reliably reproduced.

There is one other safeguard required for an experiment. Researchers must be able to **replicate** the results—that is, repeat an experiment to see whether the results can be reliably reproduced. Unless a study can be replicated, the results are likely to be a fluke occurrence. If an experimental result can be obtained only once, we must conclude that it was caused by some chance variable and not by the independent variable. This means there is no apparent cause-and-effect relationship between the IV and the DV. In our study hall experiment, replication studies might involve repeating the experiment at different schools or under slightly different conditions. Replication helps us know that the results apply in a variety of situations, and it depends on having clear operational definitions for all our variables. It is no accident that our topic in this module is *re*search—not search. Researchers have to demonstrate their findings again and again and again!

MAKE IT STICK!

1. Why are placebos used in some experiments?

a. They provide a way for the dependent variable to vary.
b. They allow for statistical analysis of results.
c. They are necessary for observational studies.
d. They help control for some confounding variables.

2. Explain why random assignment is a critical feature of experimental design.

3. Which of the following is the best operational definition of learning in an experiment designed to identify techniques to help students learn math formulas?

a. Students' scores in other courses
b. Students' scores on a test over math formulas
c. The quality of the teacher
d. The number of minutes the teacher spends instructing students about the formulas

4. For the hypothesis *students who sleep more than 8 hours on school nights will have higher GPAs than students who sleep less than 8 hours on school nights,* what is the independent variable?

a. The amount of sleep
b. Students who sleep less than 8 hours
c. GPA
d. The night of the week

5. Repeating an experiment to see whether the results can be reliably reproduced is called ______.

Research Ethics

3-8 What ethical guidelines are in place to protect the rights of human research participants and animal research subjects?

Is it ethical (morally proper) to force people to participate in research if they don't want to? According to current standards, *no.* Is it ethical to tell people that an experiment is about one's ability to solve math problems when it is really about how one behaves under stress? Current ethical standards allow researchers to deceive participants (as long as they clear up the deception at the end of the project), so this answer is *yes.* There are ethical considerations with all research, especially when the participants are humans. These ethical issues extend well beyond the methodological issues we have been discussing so far. For moral reasons, many hypotheses cannot be tested experimentally, even though we could design sound experiments that would provide good answers. For example, suppose your hypothesis is that children who are disciplined by being whipped with a belt will not behave as well as children disciplined without physical punishment. This experiment would be quite simple to set up. The IV would be exposure to whippings, and the DV would be some measure of behavior, such as number of broken rules. You would then choose a sample of participants and randomly assign them to two groups. Those in the experimental group would be whipped by their parents, and those in the control group would be disciplined by their parents in other ways. Here we have a straightforward experimental design, but it would be unethical to conduct this experiment. You would be exposing your experimental group participants to a procedure that you believe would harm them.

Human Research

Most research takes place on university campuses, where ethics committees screen all research proposals in advance. The committee checks that the research will comply with the strict ethical guidelines for research with human participants set by the American Psychological Association. There are four basic principles:

- *Informed consent.* Researchers must inform potential participants in advance about the general nature of the research and any potential risks involved. Participants must understand that they have a right to refuse to participate or to withdraw at any time. To hide specific details of the research is permissible if the general nature and potential risks are accurately portrayed.
- *The right to be protected from harm and discomfort.* Researchers may conduct studies that involve harm and discomfort only under certain circumstances and only with the participants' informed consent.
- *The right to confidentiality.* Researchers must never release data about individual participants, and members of the research team may not gossip or spread information about the participants.
- *The right to debriefing.* Participants must receive a full explanation of the research when their involvement is done. This is especially important if the research has included deception about specific details of the procedure.

Animal Research

The four ethical principles discussed here help protect the rights of human research participants, but what about animals? We sometimes hear media reports of research that seems to subject animals to unwarranted cruelty, pain, and suffering. Why are animals used in research? What is done to protect them?

Psychologists use animals in research for several reasons:

- Many psychologists are simply interested in how animals behave. It is a fascinating and legitimate field of study.
- There are biological and behavioral similarities between animals and humans. Therefore, by studying animals, we can learn things that apply to humans.
- Because many species of animals develop more rapidly and therefore have shorter life spans than humans do, we can study genetic effects over generations much more rapidly in animals than in humans.
- It is often possible to exercise more control over experiments with animals than over those with humans. For example, researchers can observe animals 24 hours a day and control their diet completely. Humans usually will not agree to such conditions.
- Procedures that are not ethical to perform on humans may be considered acceptable when performed on animals. My sister-in-law once had a job in a medical laboratory, where she performed surgery on unclaimed dogs that had been slated to be killed at a local animal shelter. She tied off an artery and created heart attacks in these dogs so that researchers could run controlled tests of

experimental drugs designed for human heart attack patients. Is it right to place the needs of humans above those of animals? It's a difficult question, but we live in a society where some animals (cows and chickens) are raised for food and others (rats and insects) are exterminated to reduce the threat of disease. Since it has given rise to so many valuable findings, supporters of animal research argue that it's permissible to use or even kill animals for the good of humans.

Remains/istock/Getty Images

Ethics of Animal Research Despite stories about the abuse of animals in the cosmetics industry, there are many regulations to protect the animals used by psychological researchers. In fact, many psychologists choose to study animals because they care about the animals and what they can teach us.

So, what is done to protect animals from abuses? Federal legislation has been passed to protect animals used in research. This legislation, which has the support of the vast majority of researchers,[4] says that animals must have clean housing, adequate ventilation, and appropriate food, and that they must be otherwise well cared for.

Just as every marathon runner is also an athlete and every pianist is also a musician, every psychologist is also a scientist. This means psychologists use a particular set of research strategies to learn about behavior and mental processes. All the factual information you will read in this book was gathered using these research methods. Your knowledge of these methods will deepen your understanding of psychology and help prepare you to think critically in a world where research can (and should) drive many decisions. Now, what will you say when your school administrators announce that new study hall music policy?

MAKE IT STICK!

1. ______ occurs when a research participant knows the general nature of the research and agrees to participate.
2. ______ is when a participant receives a full explanation at the conclusion of the research.
3. Explain one reason why psychologists use animals in research.

Module 3 Summary and Assessment

Research Strategies

3-1 What advantage does research have over other ways of knowing things?

- Well-designed research produces data-supported conclusions.
- Research is better than common sense at providing reliable, logical answers to questions.

3-2 What are some ways that bias can influence research?

- Bias is any influence that unfairly increases the possibility that we will reach a particular conclusion.
- Research can be negatively influenced by a researcher's confirmation bias and by participant bias.

3-3 Why do psychologists use case studies?

- Case studies collect in-depth information on a single person or situation. However, researchers cannot know from the case study alone if the conclusions are true for other people or situations.

3-4 Why is it impossible to conclude cause-and-effect relationships from correlational data?

- A correlational study tells us the extent to which two variables are related. If the variables change in the same direction, then it's a positive correlation; if the variables change in opposite directions, then it's a negative correlation. Correlations do not establish that there is a cause-and-effect relationship between the two variables. We do not know if one of the two variables caused the change or even if a third variable caused the change in each of the correlated variables.

3-5 Why should we be cautious when applying data obtained from surveys?

- Surveys are an efficient way to collect information about people's attitudes or behaviors by asking questions on a questionnaire or in an interview. Researchers must be careful to construct unbiased questions and to use a random sample to draw adequate conclusions about their populations.

3-6 Why do psychologists conduct longitudinal and cross-sectional studies?

- These techniques allow psychologists to study how individuals change across the life span. Longitudinal studies follow the same group for many years. Cross-sectional studies compare people of different ages at one time.

3-7 Why are experiments the most powerful research technique of all, and what factors contribute to the design of an experiment?

- Only experiments can establish cause-and-effect relationships. They do this by generating a hypothesis with operationalized independent and dependent variables, by randomly selecting participants and randomly assigning them to the experimental and control groups to control for confounding variables, and by controlling for other confounding variables relating to expectations and environmental differences.
- Data from experiments must be analyzed to reveal statistically significant conclusions.
- It must be possible to replicate experimental results before a cause-and-effect relationship can be concluded.

3-8 What ethical guidelines are in place to protect the rights of human research participants and animal research subjects?

- Ethical guidelines for research require that human participants have the rights of informed consent, protection from harm, confidentiality, and debriefing.
- Federal guidelines protect the health and safety of animals used in research.

Summative Assessment

1. A tendency to focus on information that supports what I already believe to be true is called

a. critical thinking.
b. participant bias.
c. a confounding variable.
d. confirmation bias.

2. Which of the following is naturalistic observation?

a. A principal comes in to the classroom to evaluate a teacher.
b. A marketing researcher sits outside of a busy store at the mall and notes what percentage of the people leaving the store are carrying bags or packages.
c. A coach times potential team members to see how fast they can run 100 meters.
d. A father supervises as his son picks up his toys.