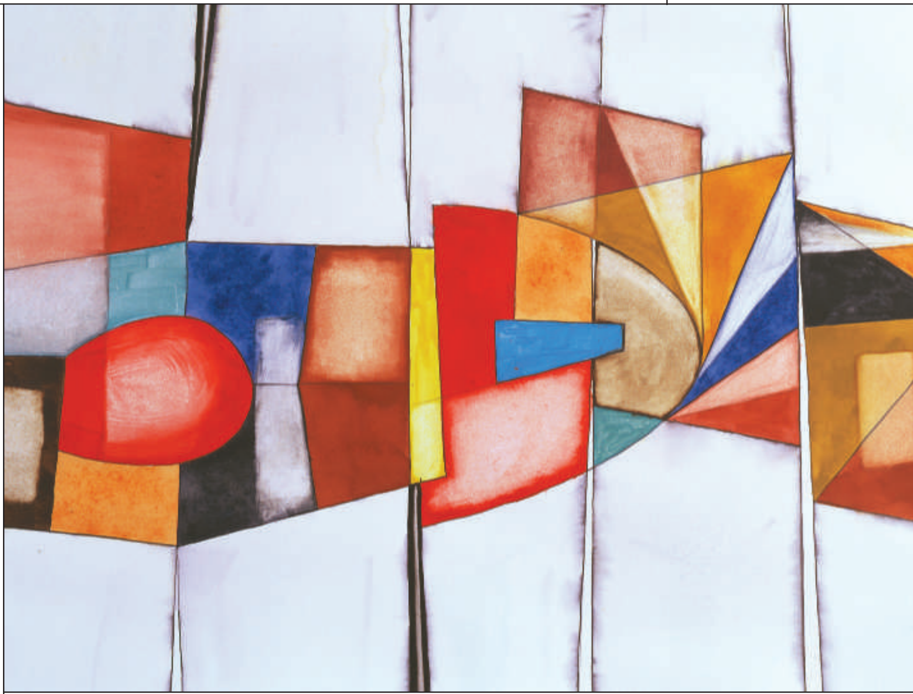
CHAPTER

7

The Experimental Research Strategy



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CHAPTER LEARNING OBJECTIVES

LO1 Describe the general purpose of an experimental research study, differentiate experiments from other types of research, and identify examples of experiments.

LO2 Define *independent, dependent,* and *extraneous variables* and identify examples of each in an experiment.

LO3 Describe the third-variable problem and the directionality problem, identify these problems when they appear in a research study, and explain why they must be eliminated before an experiment can demonstrate a cause-and-effect relationship.

LO4 Explain why manipulation of an independent variable is a critical component of an experiment.

LO5 Explain why control of extraneous variables is a critical component of an experiment.

LO6 Explain how an extraneous variable can become a confounding variable and identify confounding variables when they appear in a research study.

LO7 Describe the three primary techniques for controlling extraneous variables (holding constant, matching, and randomization), explain how each one works, and identify these techniques when they appear in a research report.

LO8 Describe the purpose for control conditions in experimental research, define the two basic types of control conditions (*no-treatment* and *placebo*), and identify control conditions when they appear in research reports.

LO9 Explain when a manipulation check is needed, describe what it is intended to accomplish, and identify a manipulation check when one appears in a research report.

LO10 Define *field studies* and *simulation*, explain why they are used as alternatives to laboratory experiments, and identify these techniques when they appear in a research report.

CHAPTER OVERVIEW

In this chapter, we discuss details of the experimental research strategy. The goal of experimental research is to establish and demonstrate a cause-and-effect relationship between two variables. To accomplish this goal, an experiment must manipulate one of the two variables and isolate the two variables being examined from the influence of other variables. Consider the following example.

In recent years, a number of research studies have examined the relationship between violent video games and aggressive behavior. For example, Gentile, Lynch, Linder, and Walsh (2004) surveyed over 600 eighth- and ninth-grade students asking about their gaming habits and other behaviors. Their results clearly showed that the adolescents who were exposed to more video game violence were more hostile, had more frequent arguments with teachers, more physical fights, and poorer performance in school than their peers who had less exposure to video game violence. Although this study established a strong relationship between violent video games and negative behaviors, the authors could not conclude that the games were responsible for *causing* the behaviors. It is possible, for example, that students who were already more aggressive and disruptive choose to play games with more violence and their more passive peers prefer less violence in their video games. In other words, it is possible that the violent games are not causing students to become aggressive; instead, it is the preexisting level of aggressiveness that is causing students to play certain games.

Other researchers took a different approach to examining the relationship between video game violence and aggressive behavior. For example, Polman, de Castro, and van Aken (2008) randomly divided a sample of 19 boys, all around 10 years old, between two treatment conditions: playing a violent video game or playing a nonviolent game. After the game-playing session, the children went to a free-play period and were monitored for aggressive behaviors, which were defined as hitting, kicking, pushing, frightening, name calling, fighting, quarreling, or teasing another child. The results clearly showed that the boys in the violent game condition displayed significantly more aggression than did the boys in the nonviolent game condition. Based on this result, the authors confidently concluded that the violence in the video games was responsible for causing the increase in aggressive behavior.

Notice that the Polman et al. study makes a cause-and-effect conclusion but the Gentile et al. study does not. How is this possible? The answer is in the details of the two studies. Specifically, the Polman et al. study used the experimental research strategy and the Gentile study did not. In this chapter, we discuss experimental research, and identify the characteristics that define true experiments and differentiate these studies from other kinds of research.

7.1 Cause-and-Effect Relationships

LEARNING OBJECTIVES

LO1 Describe the general purpose of an experimental research study, differentiate experiments from other types of research, and identify examples of experiments.

LO2 Define *independent*, *dependent*, and *extraneous variables* and identify examples of each in an experiment.

LO3 Describe the third-variable problem and the directionality problem, identify these problems when they appear in a research study, and explain why they must be eliminated before an experiment can demonstrate a cause-and-effect relationship.

In Chapter 6, we identified five basic strategies for investigating variables and their relationships: descriptive, correlational, experimental, quasi-experimental, and nonexperimental. In this chapter, we discuss details of the experimental research strategy. (The nonexperimental and quasi-experimental strategies are discussed in Chapter 10, the correlational strategy in Chapter 12, and the descriptive strategy in Chapter 13.)

More complex experiments may involve several variables. In its simplest form, however, an experiment focuses on only one variable that may cause changes in one other variable.

The goal of the **experimental research strategy** is to establish the existence of a cause-and-effect relationship between two variables. To rule out the possibility of a coincidental relationship, an **experiment**, often called a **true experiment**, must demonstrate that changes in one variable are directly responsible for causing changes in the second variable. To accomplish this goal, an experimental study contains the following four basic elements, which are also shown in Figure 7.1:

1. *Manipulation.* The researcher manipulates one variable by changing its value to create a set of two or more treatment conditions.
2. *Measurement.* A second variable is measured for a group of participants to obtain a set of scores in each treatment condition.
3. *Comparison.* The scores in one treatment condition are compared with the scores in another treatment condition. Consistent differences between treatments provide evidence that the manipulation has caused changes in the scores (see Box 7.1).
4. *Control.* All other variables are controlled to be sure that they do not influence the two variables being examined.

Although the term *experiment* is often used casually to describe any scientific research study, only those studies satisfying these four requirements are actually real experiments.

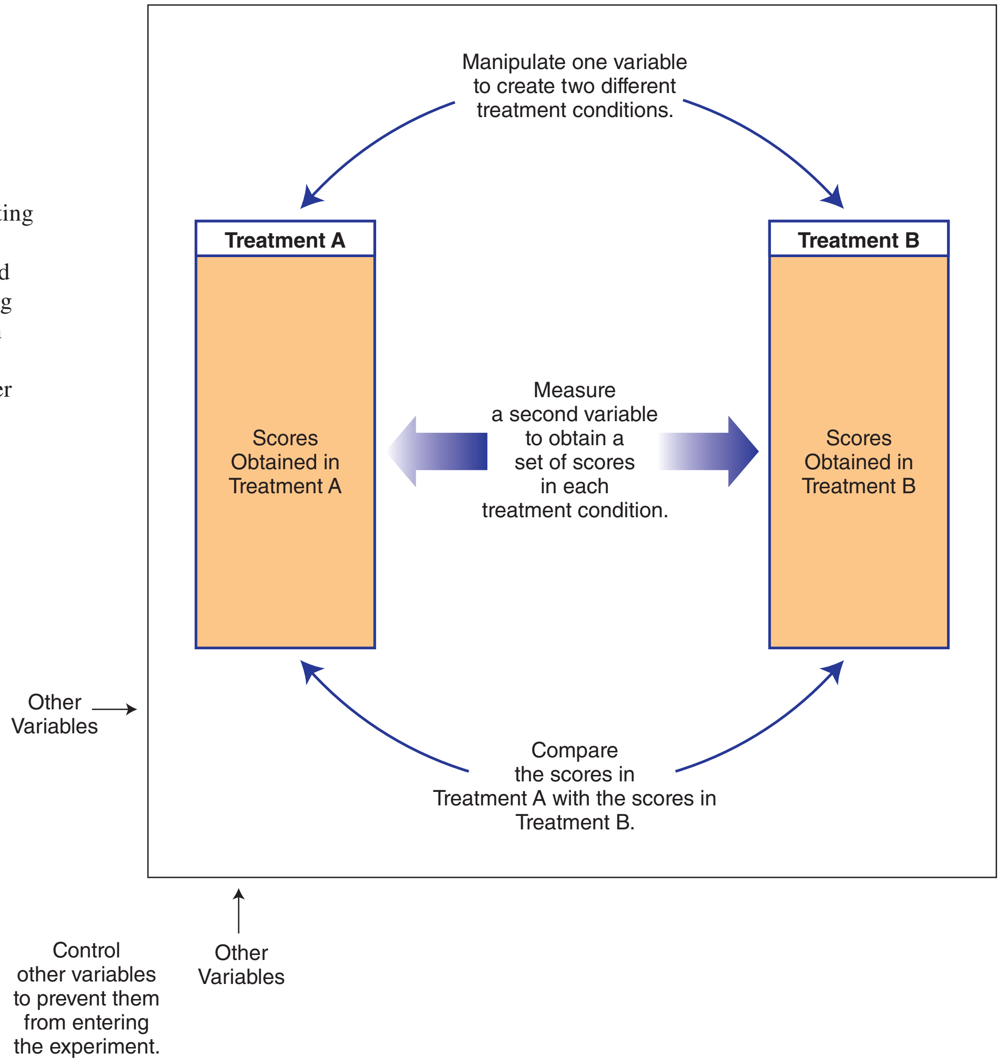
Caution! Not all research studies are experiments.

Earlier in the chapter, for example, we described a study by Polman et al. (2008) examining the relationship between video game violence and aggressive behavior. In the study, one group of boys was given a violent video game and another group received a nonviolent game. Notice that the researchers are *manipulating* the violence of the game by changing from violent to nonviolent. They then *measured* the behavior of the boys during a free-play period after the video games. Aggressive behavior for boys with the violent game was then *compared* with behavior for boys with the nonviolent game. During the study, the researchers *controlled* other variables by ensuring that both groups consisted of 10-year-old boys (same age and same gender) and randomly assigning participant to the different games to ensure that other variables were balanced across the two conditions. The results showed more aggressive behavior after playing a violent game than after playing a nonviolent game.

FIGURE 7.1

The Basic Components of an Experimental Research Study

An experiment involves manipulating one variable, measuring a second variable, comparing the scores between treatments, and controlling all other variables.



Terminology for the Experimental Research Strategy

In an experiment, the variable that is manipulated by the researcher is called the **independent variable**. Typically, the independent variable is manipulated by creating a set of **treatment conditions**. The specific conditions that are used in the experiment are called the **levels** of the independent variable. The variable that is measured in each of the treatment conditions is called the **dependent variable**. All other variables in the study are **extraneous variables**. For the Polman et al. (2008) video violence example, the independent variable is the level of violence in the video game, and there are two levels: violent and nonviolent. The dependent variable is the aggressive behavior observed after each of the two games. Other variables, such as the participants' personality, height, and weight, as well as environmental variables, such as the season and the weather conditions, are extraneous variables.

BOX 7.1 Statistical Significance

Whenever you compare two sets of scores that were obtained at different times or came from different people, the two sets will never be *exactly* the same. Small differences from one person to another (or from one time to another) always produce small differences between the two sets of scores. As long as the differences are small and random (one set does not have consistently larger scores than the other), they probably are meaningless and can be attributed to chance. For example, if you drew a line through the center of your classroom and computed the average age for students on the right side and for students on the left side, the two averages would be different. However, the age difference is simply the result of chance and should not be interpreted as evidence for some mysterious force that causes older students to gravitate toward one side of the room.

In an experiment, the scores in one treatment condition are compared with the scores in another condition. If there is a difference between the scores, however, you cannot automatically conclude that the treatments have *caused* a difference. As we noted earlier, the difference may simply be the result of chance. Before you can interpret the difference as a cause-and-effect relationship, you must conduct a hypothesis test and demonstrate that the difference is statistically significant. A significant result means that the difference is large enough and consistent enough for a hypothesis test to rule out chance as a plausible explanation, and thereby conclude that the difference must have been caused by the treatments. Chapter 15 presents a detailed presentation of hypothesis testing and statistical significance. For now, you should realize that any difference between treatment conditions must be evaluated statistically before you can conclude that the difference was caused by the treatments.

DEFINITIONS

The **experimental research strategy** establishes the existence of a cause-and-effect relationship between two variables. To accomplish this goal, an experiment manipulates one variable while a second variable is measured and other variables are controlled.

An **experiment** or a **true experiment** attempts to show that changes in one variable are directly responsible for changes in a second variable.

In an experiment, the **independent variable** is the variable manipulated by the researcher. In behavioral research, the independent variable usually consists of two or more treatment conditions to which participants are exposed.

In an experiment, a **treatment condition** is a situation or environment characterized by one specific value of the manipulated variable. An experiment contains two or more treatment conditions that differ according to the values of the manipulated variable.

Levels are the different values of the independent variable selected to create and define the treatment conditions.

The **dependent variable** is the variable that is observed for changes to assess the effects of manipulating the independent variable. The dependent variable is typically a behavior or a response measured in each treatment condition.

Extraneous variables are all variables in the study other than the independent and dependent variables.

Finally, you should note that in this book, we use the terms *experiment* and *true experiment* in a well-defined technical sense. Specifically, a research study is called an experiment only if it satisfies the specific set of requirements that are detailed in this chapter. Thus, some research studies qualify as true experiments whereas other studies, such as correlational studies, do not. In casual conversation, people tend to refer to any kind of research study as an experiment. ("Scientists" do "experiments" in the "laboratory.") Although this casual description of research activity is acceptable in some contexts, we are careful to distinguish between experiments and other research studies. Therefore, whenever the word experiment is used in this text, it is in this more precise, technical sense. This chapter introduces the characteristics that differentiate a true experiment from other kinds of research studies.

Causation and the Third-Variable Problem

One problem for experimental research is that variables rarely exist in isolation. In natural circumstances, changes in one variable are typically accompanied by changes in many other related variables. For example, in the video game violence experiment (p. 158), the researchers manipulated the level of violence in the game. Under normal circumstances, however, the violence level of the game depends on the set of games that the child owns, and which game is selected on a specific day and time. As a result, in natural circumstances researchers are often confronted with a tangled network of interrelated variables. Although it is relatively easy to demonstrate that one variable is related to another, it is much more difficult to establish the underlying cause of the relationship. To determine the nature of the relationships among variables, particularly to establish the causal influence of one event on another, it is essential that an experiment separate and isolate the specific variables being studied. The task of teasing apart and separating a set of naturally interconnected variables is the heart of the experimental strategy.

Earlier we noted that a relationship between two variables can be simply coincidental and not causal. For example, if a researcher measures weight and mathematical ability for a group of children who are 6–12 years old, there will be a strong relationship between the two variables: as weight increases from child to child, mathematical ability also tends to increase. However, this does not mean that an increase in weight causes an increase in mathematics ability. Instead, it is the age of the children that is responsible for the observed relationship: As age increases from 6 to 12, the children tend to weigh more and as age increases from 6 to 12, children tend to have more mathematics education. This is an example of the **third-variable problem**. Although a study may establish that two variables are related, it does not necessarily mean that there is a direct (causal) relationship between the two variables. It is always possible that a third (unidentified) variable is controlling the two variables and is responsible for producing the observed relation. For example, although there is a relationship between weight and mathematical ability for children, common sense suggests that this is not a causal relationship. A more reasonable interpretation is that another variable, such as age, is responsible for the systematic differences in both weight and mathematical ability.

Causation and the Directionality Problem

A second problem for researchers attempting to demonstrate cause-and-effect relationships is demonstrated in the Gentile et al. (2004) video gaming example described at the beginning of this chapter. In this study the researchers simply asked the students about their video game habits and other behaviors. Although the study found higher aggressive behavior for students who reported using more violent games, the results do not support a conclusion that an increase in video game violence causes an increase in aggressive behavior. Instead, it could be that aggressive behavior causes an increase in video game violence. As noted earlier, it is possible that students who are naturally more aggressive prefer to play games that are more violent.

This example is a demonstration of the **directionality problem**. Although a research study may establish a relationship between two variables, the existence of a relationship does not always explain the direction of the relationship. The remaining problem is to determine which variable is the cause and which is the effect.

Controlling Nature

The preceding examples demonstrated that we cannot establish a cause-and-effect relationship by simply observing two variables. In particular, the researcher must actively unravel the tangle of relationships that exists naturally. To establish a cause-and-effect relationship, an experiment must control nature, essentially creating an unnatural situation wherein the two variables being examined are isolated from the influence of other variables and wherein the exact character of a relationship can be seen clearly.

We acknowledge that it is somewhat paradoxical that experiments must interfere with natural phenomena to gain a better understanding of nature. How can observations made in an artificial, carefully controlled experiment reveal any truth about nature? One simple answer is that the contrived character of experiments is a necessity: To see beneath the surface, it is necessary to dig. A more complete answer, however, is that there is a difference between the conditions in which an experiment is conducted and the results of the experiment. Just because an experiment takes place in an unnatural environment does not necessarily imply that the results are unnatural.

For example, you are probably familiar with the law of gravity, which states that all objects fall at the same rate independent of mass. You are, no doubt, equally familiar with the "natural" fact that if you drop a brick and a feather from the roof of a building, they will not fall at the same rate. Other factors in the natural world, such as air resistance, conceal the true effects of gravity. To demonstrate the law of gravity, we must create an artificial, controlled environment (specifically, a vacuum) wherein forces such as air resistance have been eliminated. This fact does not invalidate the law of gravity; the law accurately describes the underlying force of gravity and explains the behavior of falling objects, even though natural conditions may conceal the basic principle. In the same way, the goal of any experiment is to reveal the natural underlying mechanisms and relationships that may be otherwise obscured. Nonetheless, there is always a risk that the conditions of an experiment are so unnatural that the results are questionable. To use the terminology presented in Chapter 6, an experimenter can be so intent on ensuring internal validity that external validity is compromised. Researchers are aware of this problem and have developed techniques to increase the external validity (natural character) of experiments. We discuss some of these techniques in Section 7.5.

LEARNING CHECK

1. How do studies using the experimental research strategy differ from other types of research?
   - **a.** Only experiments can demonstrate a cause-and-effect relationship between variables.
   - **b.** Only experiments involve comparing two or more groups of scores.
   - **c.** Only experiments can demonstrate that relationships exist between variables and provide a description of the relationship.
   - **d.** Only experiments can demonstrate a bidirectional relationship between variables.

2. Dr. Jones is interested in studying how indoor lighting can influence people's moods during the winter. A sample of 100 households is selected. Fifty of the homes are randomly assigned to the bright-light condition where Dr. Jones replaces all the lights with 100-watt bulbs. In the other 50 houses, all the lights are changed to 60-watt bulbs. After two months, Dr. Jones measures the level of depression for the people living in the houses. In this example, how many dependent variables are there?
   a. 100
   b. 50
   c. 2
   d. 1
3. Research indicates the people who suffer from depression also tend to experience insomnia. However, it is unclear whether the depression causes insomnia or the lack of sleep causes depression. What problem is demonstrated by this example?
   a. the directionality problem
   b. the third-variable problem
   c. the extraneous variable problem
   d. the manipulation-check problem

Answers appear at the end of the chapter.

7.2 Distinguishing Elements of an Experiment

LEARNING OBJECTIVES

LO4 Explain why manipulation of an independent variable is a critical component of an experiment.

LO5 Explain why control of extraneous variables is a critical component of an experiment.

LO6 Explain how an extraneous variable can become a confounding variable and identify confounding variables when they appear in a research study.

The general purpose of the experimental research strategy is to demonstrate the existence of a cause-and-effect relationship between two variables. That is, an experiment attempts to demonstrate that changing one variable (the independent variable) causes changes in a second variable (the dependent variable). This general purpose can be broken down into two specific goals.

1. The first step in demonstrating a cause-and-effect relationship is to demonstrate that the "cause" happens before the "effect" occurs. In the context of an experiment, this means that you must show that a change in the value of the independent variable is followed by a change in the dependent variable. To accomplish this, a researcher first manipulates the independent variable and then observes the dependent variable to see if it also changes.
2. To establish that one specific variable is responsible for changes in another variable, an experiment must rule out the possibility that the changes are caused by an extraneous variable.

Earlier, we described the experimental research strategy as consisting of four basic elements: manipulation, measurement, comparison, and control. Two of these elements, measurement and comparison, are also components in a number of other research strategies. However, the two elements that are unique to experiments and distinguish experimental research from other strategies are manipulation of one variable and control of extraneous variables. These two unique elements of experimental research are discussed in the following sections.

Manipulation

A distinguishing characteristic of the experimental strategy is that the researcher manipulates one of the variables under study. **Manipulation** is accomplished by first deciding which specific values of the independent variable you would like to examine. Then you create a series of treatment conditions corresponding to those specific values. As a result, the independent variable changes from one treatment condition to another. For example, if you wanted to investigate the effect of temperature (independent variable) on appetite (dependent variable), you would first determine which levels of temperature you wanted to study. Assuming that 70 degrees Fahrenheit is a "normal" temperature, you might want to compare 60 degrees, 70 degrees, and 80 degrees to see how warmer- or colder-than-normal temperatures affect appetite. You would then set the room temperature to 60 degrees for one treatment condition, change it to 70 degrees for another condition, and change it again to 80 degrees for the third condition. A group of participants or subjects is then observed in each treatment condition to obtain measurements of appetite.

DEFINITION

> In an experiment, **manipulation** consists of identifying the specific values of the independent variable to be examined and then creating a set of treatment conditions corresponding to the set of identified values.

Manipulation and the Directionality Problem

The primary purpose of manipulation is to allow researchers to determine the direction of a relationship. Suppose, for example, there is a systematic relationship between temperature and ice-cream sales at major-league baseball stadiums, so that temperature and ice-cream sales rise and fall together. This relationship is shown in Figure 7.2. As we have noted, however, simply observing that a relationship exists does not explain the relationship and certainly does not identify the direction of the relationship. One technique for determining the direction of a relationship is to manipulate one of the variables (cause it to increase and decrease) and watch the second variable to determine whether it is affected by the manipulation. We could, for example, select enclosed baseball stadiums and use the heating/cooling system to manipulate the temperature while monitoring ice-cream consumption. In this situation, it is reasonable to expect that increasing the temperature would produce an increase in ice-cream consumption. On the other hand, we could manipulate ice-cream consumption (hand out free ice cream) and monitor temperature. In this case, it is unlikely that more ice-cream consumption would result in higher temperatures. Note that manipulation of the individual variables allows us to demonstrate the direction of the relationship: Changes in temperature are responsible for causing changes in ice-cream consumption, not the other way around. In general, whenever there is a relationship between two variables, a researcher can use manipulation to determine which variable is the cause and which is the effect.

For an example more closely related to psychology, consider the relationship between depression and insomnia. It has been observed repeatedly that people suffering from depression also tend to have problems sleeping. However, the observed relationship does not answer the causal question, "Does depression cause sleep problems, or does the lack of sleep cause depression?" Although it may be difficult to manipulate depression

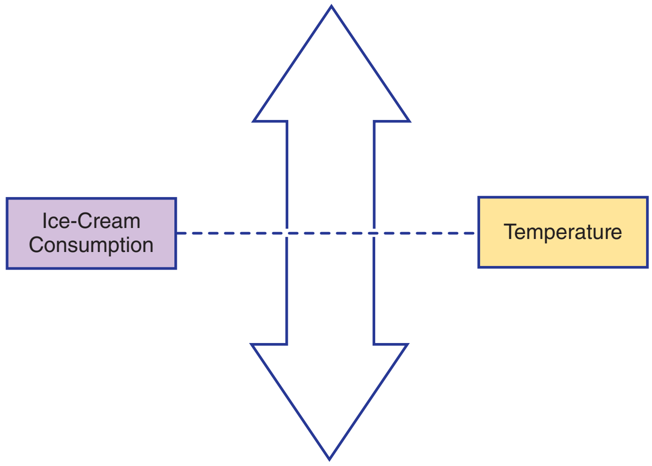


FIGURE 7.2

Using Manipulation to Determine the Direction of a Cause-and-Effect Relationship

Ice-cream consumption and temperature rise and fall together. Manipulating temperature (increasing or decreasing) causes a corresponding change in ice-cream consumption. However, increasing ice-cream consumption by handing out free ice cream has no influence on temperature.

directly, it certainly is possible to manipulate the amount of sleep. One group of individuals, for example, could be allowed only 4 hours of sleep each night and a comparison group allowed 8 hours. After a week, depression scores could be obtained and compared for the two groups. If the 4-hour group is more depressed, this is evidence that a lack of sleep causes depression. Notice that the researcher is not directly manipulating depression. Instead, the researcher hopes and expects that manipulating the amount of sleep will produce a change in depression.

Manipulation and the Third-Variable Problem

A second purpose for manipulation is to help researchers control the influence of outside variables. In an experiment, researchers must actively manipulate the independent variable rather than simply waiting for the variable to change by itself. If you let variables change on their own, it is always possible that other variables are also changing, and these other variables may be responsible for the relationship you are observing. Earlier, we speculated about a relationship between ice-cream consumption and temperature: Increasing temperature is related to increased ice-cream consumption. Similarly, there is a relationship between temperature and crime (Cohn & Rotton, 2000). These two relationships are shown together in Figure 7.3. Notice that increasing temperature is related to both an increase in ice-cream consumption and an increase in crime. If a researcher simply observed ice-cream consumption and crime rates, the results would indicate a strong relationship: Increases in ice-cream consumption are accompanied by increases in crime. However, the existence of a relationship does not necessarily mean that there is a direct connection between the two variables. As in Figure 7.3, it is possible that a third, outside variable is responsible for the apparent relationship. The lack of any direct connection between variables can be demonstrated using manipulation. In this example, we could manipulate ice-cream consumption (hand out free ice cream) and monitor crime rates. Presumably, increasing ice-cream consumption would have no influence on crime rates. Similarly, we could manipulate crime rates (start a massive police initiative) and monitor ice-cream consumption. Again, it is unlikely that changing the crime rate would have any effect on ice-cream consumption. Notice that we are using manipulation to show that there is not a direct cause-and-effect relationship between crime and ice-cream consumption.

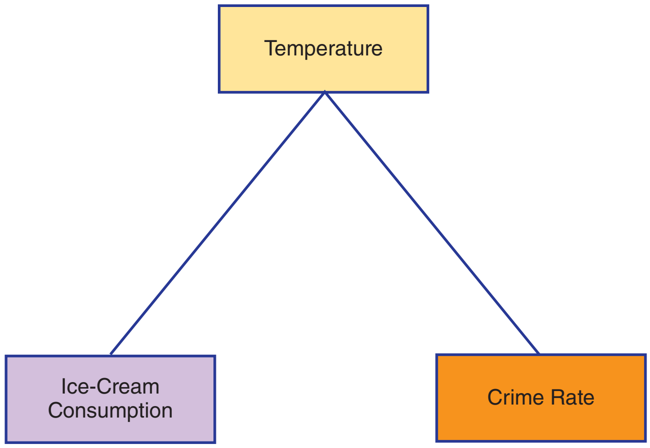


FIGURE 7.3

Manipulation and the Third-Variable Problem

Ice-cream consumption and crime rate rise and fall together as temperature increases and decreases. However, there is no direct connection between ice-cream consumption and crime rate. Manipulating either of the two variables will have no influence on the other.

Specifically, you can manipulate either crime rate or ice-cream consumption and it will have no effect on the other variable.

In an experiment, the researcher is responsible for causing the independent variable to change by direct manipulation. In this way, the researcher can be confident that changes in the independent variable are not being caused by some outside variable (a third variable) that could influence the outcome of the study. Thus, the act of manipulation helps eliminate one aspect of the third-variable problem in an experiment.

Control

The second distinguishing characteristic of an experiment is control of other variables; specifically, variables other than the independent and dependent variables. To accurately evaluate the relationship between two specific variables, a researcher must ensure that the observed relationship is not contaminated by the influence of other variables.

Control and the Third-Variable Problem

In general, the purpose of an experiment is to show that the manipulated variable is responsible for causing the changes observed in the dependent variable. To accomplish this, an experiment must rule out any other possible explanation for the observed changes; that is, eliminate all **confounding variables**. In Chapter 6 (p. 148) we defined a *confounding variable* as a third variable that is allowed to change systematically along with the two variables being studied. In the context of an experiment, the particular concern is to identify and control any third variable that changes systematically along with the independent variable and has the potential to influence the dependent variable.

A confounding variable and the need for control are illustrated in the following example. A researcher designs a study to determine whether preschool children prefer sweetened or unsweetened cereal. For one group, the researcher uses a box of colorful sweetened cereal and for the other group, a box of tan-colored unsweetened cereal. The results showed that the preschoolers ate more of the sweetened colorful cereal and therefore prefer the sweetened cereal.

However, you should realize that this study contains a potentially confounding variable. Specifically, the color of the cereal varies systematically with the sweetness of the cereal. In this experiment, it is impossible to tell whether the preference for the colorful sweetened cereal is caused by the color or the sweetness. The structure of this study, including the confounding variable, is shown in Figure 7.4.

To establish an unambiguous causal relationship between sweetness and preference, it is necessary to eliminate the possible influence of the confounding variable. For this study, one solution is to eliminate the color variable. For example, one group is given colorful sweetened cereal and the second group gets colorful unsweetened cereal. The structure of the controlled experiment is shown in Figure 7.5. In the controlled experiment, the confounding variable has been eliminated, and the true relation between sweetness and cereal preference can be observed.

The cereal example provides an opportunity to make another important point. Specifically, the independent variable in an experiment is determined by the hypothesis. Because the original study intended to examine the effect of sweetness on cereal preference, the independent variable was the sweetness of the cereal. If we wanted to examine the effect of color on cereal preference, then the independent variable would have been the color of the cereal. In a study in which color was the independent variable, the sweetness of the cereal would be a confounding variable. Thus, the classification as an independent variable or a confounding variable depends on the hypothesis.

Extraneous Variables and Confounding Variables

Although the focus in an experiment is on two specific variables, the independent and the dependent variables, there are thousands of other variables that exist within any experiment. Different individuals enter the experiment with different backgrounds, ages, genders, heights, weights, IQs, personalities, and the like. As time passes, room temperature

FIGURE 7.4

Confounding Variables

Because the sweetness of the cereal and the color of the cereal vary together systematically, they are confounded, and it is impossible to determine which variable is responsible for the differences in preferences.

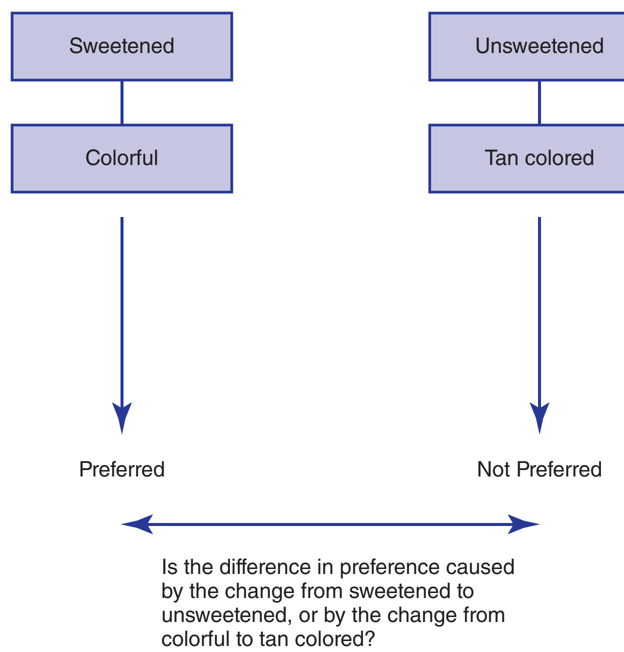
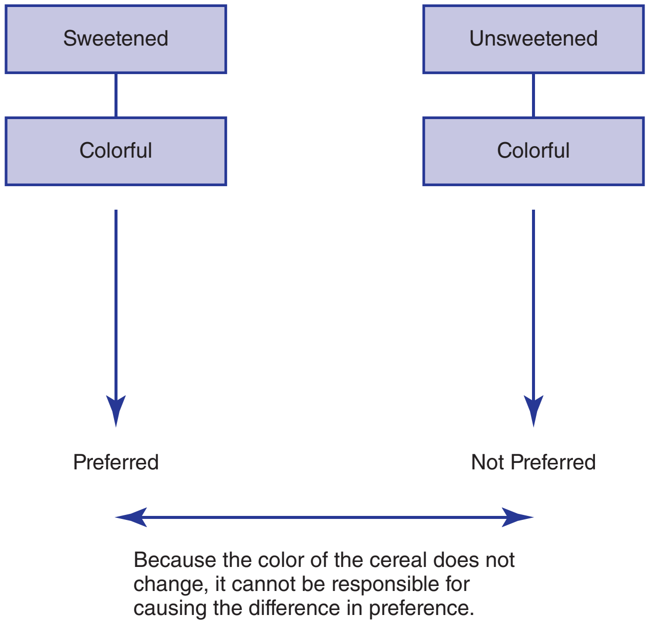


FIGURE 7.5

Eliminating a Confounding Variable

Because the level of sweetness of the cereal does not change systematically with the color of the cereal, the two variables are not confounded. In this study, you can be confident that the level of sweetness (not color) is responsible for the differences in preference.



and lighting fluctuate, weather changes, people get tired or bored or excited or happy, they forget things or remember things, and develop itches or aches and pains that distract them from the task at hand. Any of these extraneous variables have the potential to become a confounding variable.

With thousands of potentially confounding variables, however, the problem of controlling (or even monitoring) every extraneous variable appears insurmountable. Close inspection of the definition of a confounding variable (see Chapter 6, p. 148), however, reveals some hints. Note that a confounding variable has two important characteristics:

1. First, an extraneous variable becomes a confounding variable only if it influences the dependent variable. Something totally unrelated to the dependent variable is not a threat. In most experiments, for example, the participants are wearing different types of shoes (sneakers, flats, heels, loafers, or sandals); however, it is unlikely that the type of shoe has any influence on the dependent variable. Thus, it is not necessary to take any steps to control the shoe variable.
2. Second, a confounding variable must vary systematically with the independent variable. A variable that changes randomly, with no relation to the independent variable, is not a threat. The concept of random versus systematic change is an important part of control.

The first step in controlling extraneous variables is to identify those variables most likely to influence the dependent variable. This identification process is based primarily on common sense, simple logical reasoning, and past experience in controlling extraneous variables. For example, if you are measuring memory performance, IQ is a reasonable choice as a potentially confounding variable. If very young and/or very old participants are used, then age is also a variable that could reasonably affect memory performance. If memory performance is being measured in different settings or at different times, these variables also could influence performance. (A loud, busy room can create distractions that lower performance, as opposed to a quiet, empty room.) The variables you identify at this step merit special attention to ensure control. Other variables are not ignored but are handled more casually. In the following section we discuss the techniques that researcher use to control extraneous variables.

LEARNING CHECK

1. In an experiment, what is the purpose for manipulating the independent variable?
   - **a.** It helps establish the direction of the relationship by showing that the dependent variable changes when you manipulate the independent variable.
   - **b.** It helps eliminate the third-variable problem because you decide when to manipulate rather than waiting for the variable to change.
   - **c.** It helps establish the direction of the relationship and it helps eliminate the third-variable problem.
   - **d.** Manipulation does not establish the direction of the relationship or eliminate the third-variable problem.
2. In order to establish an unambiguous relationship between two variables, it is necessary to eliminate the possible influence of which of the following variables?
   - **a.** Extraneous variables
   - **b.** Confounding variables
   - **c.** Independent variables
   - **d.** Dependent variables
3. Which of the following characteristics are necessary for an extraneous variable to become a confounding variable?
   - **a.** It must change systematically from one participant to the next.
   - **b.** It must change systematically when the independent variable is changed.
   - **c.** It must have no systematic relationship with the dependent variable.
   - **d.** It must have no systematic relationship to either the independent or the dependent variables.

Answers appear at the end of the chapter.

7.3 Controlling Extraneous Variables

LEARNING OBJECTIVE

LO7 Describe the three primary techniques for controlling extraneous variables (holding constant, matching, and randomization), explain how each one works, and identify these techniques when they appear in a research report.

Once a limited set of specific extraneous variables with real potential as confounding variables is identified, it is possible to exercise some control over them. There are three standard methods for controlling extraneous variables. Two methods involve actively intervening to control variables by holding the variable constant or by matching values across the treatment conditions. The third method is randomization.

Control by Holding Constant or Matching

For now, we focus attention on the two active methods for controlling extraneous variables.

Holding a Variable Constant

An extraneous variable can be eliminated completely by holding it constant. For example, all individuals in the experiment could be observed in the same room, at the same time of day, by the same researcher. Because these factors are the same for every observation, they do not vary and, therefore, cannot be confounding variables. By standardizing the environment and procedures, most environmental variables can be held constant. This technique can also be used with participant variables. For example, by selecting only 6-year-old children to participate in an experiment, age is held constant.

Often, it is unreasonable to hold a variable completely constant. For example, it would not be practical to hold IQ constant by requiring all participants to have IQs of exactly 109. Similarly, it would be a bit overzealous to hold age constant by requiring all participants to have been born on June 13, 1999. Instead, researchers often choose to restrict a variable to a limited range instead of holding it absolutely constant. For example, a researcher may require participants to be between 18 and 21 years of age and to have IQ scores between 100 and 110. Although age and IQ are not perfectly constant here, the restricted range should ensure that the participants in one treatment are not noticeably older or smarter than the participants in another treatment.

Holding a variable constant eliminates its potential to become a confounding variable. However, this method also may have negative consequences because it can limit the external validity of an experiment. For example, if an experiment is conducted exclusively with participants from one ethnic group, the results may not generalize to another ethnic group. Recall from Chapter 6 that any factor limiting the generalization of research results is a threat to external validity.

Matching Values across Treatment Conditions

Control over an extraneous variable can also be exercised by matching the levels of the variable across treatment conditions. For example, a researcher using two samples of college students could assign 20 younger students (under age 25) and 10 older students (25 or older) to each separate treatment condition. Age still varies within treatment conditions, but it is now balanced and does not vary across treatments. Another common form of matching is to ensure that the average value is the same (or nearly the same) for all treatments. For example, participants could be assigned so that the average age is the same for all of the different treatment conditions. In this case, age is balanced across treatments and, therefore, cannot be a confounding variable. Matching can also be used to control environmental variables. For example, a study using two different rooms could match the rooms across treatment conditions by measuring half of the participants in one room and the other half in the other room for every treatment condition. Finally, matching can be used to control time-related factors. By varying the order of two treatments, I and II, some participants experience treatment I early in the series, and others experience the same treatment later. In the same way, some participants experience treatment II early and others later. In this way, the treatment conditions are matched with respect to time. The process of matching treatment conditions over time is called *counterbalancing* and is discussed in detail in Chapter 9.

Typically, controlling a variable by matching or holding constant requires some time and effort from the researcher and can intrude on the experimental participants. Matching individuals for IQ, for example, requires the researcher to obtain an IQ score for each participant before the experiment can begin. Although it is possible to control a few variables by matching or holding constant, the demands of these control techniques make them impractical or impossible to use to control all extraneous variables. Therefore, active control by matching or holding constant is recommended for a limited set of specific variables identified as potentially serious threats to an experiment.

Control by Randomization

Because it is essentially impossible to actively control the thousands of extraneous variables that can intrude on an experiment, researchers usually rely on a simpler, more passive control technique known as **randomization**. The goal of randomization is to disrupt any systematic relation between extraneous variables and the independent variable, thereby preventing the extraneous variables from becoming confounding variables.

Randomization involves using an unpredictable and unbiased procedure (such as a coin toss) to distribute different values of each extraneous variable across the treatment conditions. The procedure that is used must be a **random process**, which simply means that all the different possible outcomes are equally likely. For example, when we toss a coin, the two possible outcomes—heads and tails—are equally likely (see Chapter 5, p. 115).

One common use of randomization is **random assignment**, in which a random process such as a coin toss or a random number table (see Appendix A) is used to assign participants to treatment conditions. For an experiment comparing two treatment conditions, a researcher could use a coin toss to assign participants to treatment conditions. Because the assignment of participants to treatments is based on a random process, it is reasonable to assume that individual participant variables (such as age, gender, height, IQ, and the like) are also distributed randomly across treatment conditions. Specifically, the use of random assignment should ensure that the participant variables do not change systematically from one treatment to another and, therefore, cannot be confounding variables.

DEFINITIONS

Randomization is the use of a random process to help avoid a systematic relationship between two variables.

Random assignment is the use of a random process to assign participants to treatment conditions.

Randomization can also be used to control environmental variables. If the research schedule requires some observations in the morning hours and some in the afternoon, a random process can be used to assign treatment conditions to the different times. For example, a coin is tossed each day to determine whether treatment I or treatment II is to be administered in the morning. In this way, a morning hour is equally likely to be assigned to treatment condition I or treatment condition II. Thus, time of day is randomly distributed across treatments and does not have a systematic effect on the outcome.

Randomization is a powerful tool for controlling extraneous variables. Its primary advantage is that it offers a method for controlling a multitude of variables simultaneously and does not require specific attention to each extraneous variable. However, randomization does not guarantee that extraneous variables are really controlled; rather, it uses chance to control variables. If you toss a coin 10 times, for example, you expect to obtain a random mixture of heads and tails. This random mixture is the essence of randomization. However, it is possible to toss a coin 10 times and obtain heads every time; chance can produce a biased (or systematic) outcome. If you are using a random process (such as a coin toss) to assign people to treatment conditions, it is still possible for all the high-IQ individuals to be assigned to the same condition. In the long run, with large numbers (i.e., a large sample), a random process guarantees a balanced result. In the short run, however, especially with small numbers (i.e., a small sample), there is a chance that randomization will not work. Because randomization cannot be relied on to control extraneous variables, specific variables that have been identified as having high potential for influencing results should receive special attention and be controlled by matching or holding constant. Then, other variables can be randomized with the understanding that they probably will be controlled by chance, but with the risk that randomization may not succeed in providing adequate control.

Comparing Methods of Control

The goal of an experiment is to show that the scores obtained in one treatment condition are consistently different from the scores in another treatment and that the differences are caused by the treatments. In the terminology of the experimental design, the goal is to show that differences in the dependent variable are caused by the independent variable. In this context, the purpose of control is to ensure that no variable, other than the independent variable, could be responsible for causing the scores to differ.

We have examined three different methods for controlling extraneous variables, and an example of each is shown in Table 7.1. The table shows how participant IQ can be a confounding variable and how the three methods are used to prevent confounding.

a. Column A shows two treatment conditions with 10 participants in each treatment. In this column, IQ (high and low) is confounded with the treatments; 80% of the participants in treatment I are low IQ but in treatment II, only 20% are low IQ. If this study found differences between the scores in treatment I and treatment II, the differences in scores could have been caused by the differences in IQ.
b. In column B, IQ is held constant. All the participants in treatment I are low IQ, and all the participants in treatment II are low IQ. In this case, there is absolutely no IQ difference between the two treatments, so IQ cannot be responsible for causing differences in the scores.
c. In column C, IQ is matched across the treatments. In treatment I, 40% are classified as high IQ, and in treatment II, 40% are high IQ. Again, the two groups are balanced with respect to IQ, so any differences in scores for the two treatments cannot be caused by IQ.
d. Finally, in column D, IQ is randomized across treatments. By using a random process to assign high and low IQ participants to the treatment conditions, it is reasonable to expect that IQ will be balanced across treatments. If there are no substantial IQ differences between treatments, then IQ cannot cause the scores in one treatment to be different from the scores in the other treatment.

TABLE 7.1

A Confounding Variable and Three Methods to Prevent Confounding

(A) IQ Confounded		(B) IQ Held Constant		(C) IQ Matched		(D) IQ Randomized	
Treatment		Treatment		Treatment		Treatment	
I	II	I	II	I	II	I	II
High	High	Low	Low	High	High	High	Low
High	High	Low	Low	High	High	Low	High
Low	High	Low	Low	High	High	Low	Low
Low	High	Low	Low	High	High	High	Low
Low	High	Low	Low	Low	Low	Low	High
Low	High	Low	Low	Low	Low	High	High
Low	High	Low	Low	Low	Low	High	Low
Low	High	Low	Low	Low	Low	Low	Low
Low	Low	Low	Low	Low	Low	High	High
Low	Low	Low	Low	Low	Low	Low	High

Advantages and Disadvantages of Control Methods

The two active methods of control (holding constant and matching) require some extra effort or extra measurement and, therefore, are typically used with only one or two specific variables identified as real threats for confounding. In addition, holding a variable constant has the disadvantage of limiting generalization (external validity). On the other hand, randomization has the advantage of controlling a wide variety of variables simultaneously. However, randomization is not guaranteed to be successful; chance is trusted to balance the variables across the different treatments. Nonetheless, randomization is the primary technique for controlling the huge number of extraneous variables that exist within any experiment.

LEARNING CHECK

1. In an experiment comparing two treatments, the researcher assigns participants to treatment conditions so that each condition has fifteen 7-year-old children and ten 8-year-old children. For this study, what method is being used to control participant age?
   a. Randomization
   b. Matching
   c. Holding constant
   d. Limiting the range
2. Holding a variable constant is a technique for removing one threat to ________, but it can limit the ________ of an experiment.
   a. internal validity, external validity
   b. external validity, internal validity
   c. internal validity, reliability
   d. external validity, reliability
3. Which of the following is the primary goal for randomly assigning participants to treatment conditions in an experiment?
   a. Increase the ability to generalize the results
   b. Avoid selection bias
   c. Ensure that the individuals in the sample are representative of the individuals in the population
   d. Minimize the likelihood that a participant variable (such as age or gender) becomes a confounding variable

Answers appear at the end of the chapter.

7.4 Control Conditions and Manipulation Checks

LEARNING OBJECTIVES

LO8 Describe the purpose for control conditions in experimental research, define the two basic types of control conditions (*no-treatment* and *placebo*), and identify control conditions when they appear in research reports.

LO9 Explain when a manipulation check is needed, describe what it is intended to accomplish, and identify a manipulation check when one appears in a research report.

Control Conditions

The experimental condition is often called the *experimental group* and the control condition is called the *control group*.

An experiment always involves comparison. The experimental strategy requires comparing observations of the dependent variable across different levels of the independent variable. In general terms, an experiment compares observations across different treatment conditions. However, sometimes a researcher wishes to evaluate only one treatment rather than compare a set of different treatments. In this case, it is still possible to conduct an experiment. The solution is to compare the treatment condition with a baseline "no-treatment" condition. In experimental terminology, the treatment condition is called the ***experimental condition***, and the no-treatment condition is called the ***control condition***.

DEFINITIONS

In an experiment, the **experimental condition** is the condition in which the treatment is administered and the **control condition** is the condition in which the treatment is not administered.

The variety of different ways to construct a control **condition** for an experiment can be classified into two general categories: no-treatment control **conditions** and placebo control **conditions**.

No-Treatment Control Conditions

As the name implies, a **no-treatment control condition** simply means that the participants do not receive the treatment being evaluated. The purpose of the no-treatment control is to provide a standard of normal behavior, or baseline, against which the treatment condition can be compared. To evaluate the effects of a drug, for example, an experiment could include one condition in which the drug is administered and a control condition in which there is no drug. To evaluate the effectiveness of a training procedure, the experimental group receives the training and the control group does not.

DEFINITION

In an experiment, a **no-treatment control condition** is a condition in which the participants do not receive the treatment being evaluated.

At first glance, it may appear that a treatment versus no-treatment experiment eliminates the independent variable. However, the researcher still creates treatment conditions by manipulating different values of the treatment variable; the no-treatment condition is simply a zero value of the independent variable. Thus, the experiment compares one condition having a "full amount" of the treatment with a second condition having a "zero amount" of the treatment. The independent variable still exists, and its two levels now consist of treatment and no-treatment control.

The opposite of a placebo is a nocebo, which is an inert substance that produces a negative or harmful effect (a "nocebo effect") simply because an individual expects or believes it will happen.

Placebo Control Conditions

A **placebo** is an inert or innocuous medication, a fake medical treatment such as a sugar pill or a water injection that, by itself, has absolutely no medicinal effect, but produces a positive or helpful effect simply because an individual expects or believes it will happen. Although there is no biological or pharmacological reason for a placebo to be effective, a placebo can have a dramatic effect on health and behavior (Long, Uematsu, & Kouba, 1989). The **placebo effect** is believed to be psychosomatic: The mind (psyche), rather than the placebo itself, has an effect on the body (somatic). The fact that an individual thinks or believes a medication is effective can be sufficient to cause a response to the medication.

DEFINITION

The **placebo effect** refers to a positive response by a participant to an inert medication that has no real effect on the body. The placebo effect occurs simply because the individual thinks the medication is effective.

In psychotherapy, the term *nonspecific* is often used in place of placebo to refer to the elements of therapy that are not specifically therapeutic.

Although the concept of the placebo effect originated in medical research, it has been generalized to other situations in which a supposedly ineffective treatment produces an effect. Common examples in behavioral research are the use of inactive drugs (especially when participants believe they are receiving psychotropic drugs), nonalcoholic beverages (when participants are expecting alcohol), and nonspecific psychotherapy (therapy with the therapeutic components removed).

In the context of experimental research, the placebo effect can generate serious questions about the interpretation of results. When a researcher observes a significant difference between a treatment condition and a no-treatment control condition, can the researcher be sure that the observed effect is really caused by the treatment, or is part (or all) of the effect simply a placebo effect? The importance of this question depends on the purpose of the experimental research. Investigators often differentiate between outcome research and process research.

1. *Outcome research* simply investigates the effectiveness of a treatment. The goal is to determine whether a treatment produces a substantial or clinically significant effect. It is concerned with the general outcome of the treatment rather than identifying the specific components that cause the treatment to be effective.
2. *Process research,* on the other hand, attempts to identify the active components of the treatment. In process research, it is essential that the placebo effect be separated from other, active components of the treatment.

To separate placebo effects from "real" treatment effects, researchers include one or more **placebo control conditions** in an experiment. The placebo control is simply a treatment condition in which participants receive a placebo instead of the actual treatment. Comparison of the placebo control condition with the treatment condition reveals how much treatment effect exists beyond the placebo effect. It is also common to include a third, no-treatment control condition. Comparison of the placebo control with the no-treatment condition reveals the magnitude of the placebo effect. In situations in which it is possible to identify several different elements of a treatment, researchers may conduct a component analysis, or dismantling of the treatment, using multiple control conditions in which selected elements (or combinations of elements) are included or excluded in each condition.

DEFINITION

A **placebo control condition** is a condition in which participants receive a placebo instead of the actual treatment.

As a final word of caution, you should recognize that using a control condition and the control of extraneous variables are two completely different aspects of an experiment. Control of extraneous variables is an essential component of all experiments and is required to prevent extraneous variables from becoming confounding variables and threatening the internal validity of the study. However, a control condition is an optional component that is used in some experiments but certainly not all. In particular, a research study does not need a control condition to qualify as a true experiment.

Manipulation Checks

In an experiment, a researcher always manipulates the independent variable. Although this manipulation and its results are obvious to the researcher, occasionally, there is a question about how the manipulation is perceived by the participants. Specifically, are the participants even aware of the manipulation and, if so, how do they interpret it? When these questions are important to the results or interpretation of an experiment, researchers often include a **manipulation check** as part of the study. A manipulation check directly measures whether the independent variable had the intended effect on the participant.

DEFINITION

A **manipulation check** is an additional measure to assess how the participants perceived and interpreted the manipulation and/or to assess the direct effect of the manipulation.

There are two ways to check the manipulation. First, a manipulation check may be an explicit measure of the independent variable. Suppose, for example, a researcher wants to examine the effects of mood on performance. The study involves manipulating people's moods (i.e., mood is the independent variable). The researcher may include a mood measure to make sure that the desired moods were actually induced.

A second way to check the manipulation is to embed specific questions about the manipulation in a questionnaire that participants complete after their participation in the experiment. For example, participants may be given an exit questionnaire that asks for their responses to the experiment:

Did you enjoy participating?

How long did the experiment seem to take?

Were you bored?

What do you think was the purpose of the experiment?

Did you suspect that you were being deceived?

Embedded in the questionnaire are specific questions that address the manipulation. Participants can be asked directly whether they noticed a manipulation. For example, if the room lighting was adjusted during the experimental session, you could simply ask, "Did you notice that the lights were dimmed after the first 15 minutes?" Or, "Did you notice any change in the lights during the experiment?" In an experiment in which the researcher manipulates "praise" versus "criticism" by making verbal comments to the participants, the researcher might ask, "How did the researcher respond when you failed to complete the first task?" Notice that the intent of the manipulation-check questions is to determine whether the participants perceived the manipulation and/or how they interpreted the manipulation.

Although a manipulation check can be used with any study, it is particularly important in four situations.

1. *Participant Manipulations.* Although researchers can be confident of the success of environmental manipulations (such as changing the lighting), there often is good reason to question the success of manipulations that are intended to affect participants. For example, a researcher who wanted to examine the effects of frustration on task performance might try to induce a feeling of frustration by giving one group of participants a series of impossible tasks to perform. To determine whether the participants actually are frustrated, the researcher might include a measure of frustration as a manipulation check.

2. *Subtle Manipulations.* In some situations, the variable being manipulated is not particularly salient and may not be noticed by the participants. For example, a researcher might make minor changes in the wording of instructions or in his or her apparent mood (smiling versus not smiling). Small changes from one treatment condition to another might be overlooked completely, especially when participants are not explicitly told that changes are being made.
3. *Placebo Controls.* As with a simulation, the effectiveness of a placebo depends on its credibility. It is essential that participants believe that the placebo is real; they must have no suspicion that they are being deceived. A manipulation check can be used to assess the realism of the placebo.
4. *Simulations.* In simulation research, the researcher attempts to create a real-world environment by manipulating elements within the experimental situation. The effectiveness of the simulation, however, depends on the participants' perception and acceptance. A manipulation check can be used to assess how participants perceive and respond to an attempted simulation. (Simulation is discussed in the following section.)

LEARNING CHECK

1. What is the purpose for using a control condition in an experiment?
   a. It provides a baseline that can be used to evaluate the size of the treatment effect.
   b. It minimizes the threat of a confounding variable.
   c. It is necessary to ensure the internal validity of the study.
   d. It is necessary to ensure the external validity of the study.

2. An experiment includes a treatment condition, a no-treatment control, and a placebo control. Which two conditions should be compared to determine the size of the effect that is actually caused by the treatment?
   a. Placebo versus treatment
   b. Placebo versus no treatment
   c. Treatment versus no treatment
   d. You only need to look at the scores in the placebo control condition

3. A researcher exposes people to a stressful situation (such as public speaking) to examine the effect of stress on depressed mood. Why would the researcher also include a measure of stress?
   a. It is a measure of the dependent variable.
   b. It is a measure of extraneous variables.
   c. It is a control for confounding variables.
   d. It is a manipulation check.

Answers appear at the end of the chapter.

7.5 Increasing External Validity: Simulation and Field Studies

LEARNING OBJECTIVE

LO10 Define *field studies* and *simulation*, explain why they are used as alternatives to laboratory experiments, and identify these techniques when they appear in a research report.

Once again, the goal of the experimental strategy is to establish a cause-and-effect relationship between two variables. To do this, an experiment creates an artificial, controlled environment in which the two variables being studied are isolated from outside influences.

As a result, experiments are commonly conducted in a laboratory setting. A controlled environment increases the internal validity of the research (see Chapter 6). However, by creating an artificial environment, experimenters risk obtaining results that do not accurately reflect events and relations that occur in a more natural, real-world environment. As we discussed in Chapter 6, in research terminology, this risk is a threat to external validity. One example of this problem occurs when demand characteristics are present. Recall that demand characteristics are cues given to the participant that may influence the participant to behave in a certain way. Demand characteristics, as well as reactivity, are much more likely to be problems in experiments conducted in a laboratory setting. For some research questions, a threat to external validity can be extremely serious. In particular, when research seeks cause-and-effect explanations for behavior in real-world situations, it is essential that the experimental results generalize outside the confines of the experiment. In these situations, researchers often attempt to maximize the realism of the experimental environment to increase the external validity of the results. Two standard techniques are used to accomplish this: simulation and field studies.

Simulation

Simulation is the creation of conditions within an experiment that simulate or closely duplicate the natural environment being examined. The term *natural environment* is used in a very broad sense to mean the physical characteristics of the environment, and more important, its atmosphere or mood. Most people are familiar with flight simulators that duplicate the cockpit of an airplane and allow pilots to train and be tested in a safe, controlled environment. In the same way that a flight simulator duplicates the natural environment of an airplane, researchers often use simulation so they can control the "natural environment" and observe how people behave in real-world situations.

DEFINITION

> A **simulation** is the creation of conditions within an experiment that simulate or closely duplicate the natural environment in which the behaviors being examined would normally occur.

Researchers often differentiate between mundane realism and experimental realism in the context of simulation (Aronson & Carlsmith, 1968). **Mundane realism** refers to the superficial, usually physical, characteristics of the simulation, which probably have little positive effect on external validity. For example, converting a research laboratory into a mock singles bar probably would not do much to promote "natural" behavior of participants. In fact, most participants would probably view the situation as phony and respond with artificial behaviors. **Experimental realism**, on the other hand, concerns the psychological aspects of the simulation; that is, the extent to which the participants become immersed in the simulation and behave normally, unmindful of the fact that they are involved in an experiment. Obviously, a successful simulation is far more dependent on experimental realism than on mundane realism, and often the more mundane aspects of a simulation can be minimized or eliminated.

One of the most famous and most detailed simulation experiments was conducted in 1973 by researchers at Stanford University (Haney, Banks, & Zimbardo, 1973). The intent of the research was to study the development of interpersonal dynamics and relationships between guards and inmates in a prison. An actual prison, consisting of three barred cells, a solitary confinement facility, guards' quarters, and an interview room, was built in the basement of the psychology building. A sample of 24 normal, mature, emotionally stable male college students was obtained. On a random basis, half were assigned the role of "guard" and half were assigned the role of "prisoner." The guards were issued khaki uniforms, nightsticks, and sunglasses. The prisoners' uniforms were loose smocks with ID numbers on the front and back. The prisoners were publicly arrested, charged, searched, handcuffed, and led off to jail where they were fingerprinted, photographed, stripped, sprayed with a delousing preparation, and finally given uniforms and locked up. Except for an explicit prohibition against physical punishment or aggression, little specific instruction was given to the guards or the prisoners. Almost immediately, the prisoners and guards became immersed in their roles. The interactions became negative, hostile, dehumanizing, and impersonal. Five prisoners had to be released because they developed extreme depression, crying, rage, and anxiety. When the experiment was stopped prematurely after only 6 days, the remaining prisoners were relieved, but the guards were distressed at the idea of giving up the control and power that had been part of their roles. Clearly the simulation was successful; perhaps too much so.

The Stanford prison study is an extreme example of a simulation experiment involving role-playing and a detailed simulated environment. However, this degree of detail is not always necessary for a successful simulation. For example, multiple studies have examined the process by which jurors reach their verdicts by using simulations that do not attempt to duplicate a real courtroom situation but simply provide information about the case (Bornstein et al, 2016). These studies place the emphasis was on experimental realism rather than mundane realism.

Field Studies

A simulation experiment can be viewed as an effort to bring the real world into the laboratory to increase the external validity of experimental results. An alternative procedure that seeks the same goal is to take the laboratory into the real world. Research studies conducted in a real-world environment are called **field studies**, and researchers often speak of "going into the field" as a euphemism for taking research outside the laboratory. Field settings were discussed briefly in Chapters 3 and 6 and are detailed here.

DEFINITION

> **Field study** is research conducted in a place that the participant or subject perceives as a natural environment.

Not all studies conducted in the field are experiments. For example, observational research is often conducted in a field setting.

Although it can be difficult to maintain the necessary control of a true experiment in a field study, it is possible to conduct field study experiments. Many of the more famous field study experiments involve the investigation of helping behavior or "bystander apathy" in emergency situations. In these studies, the researchers create an emergency situation, then manipulate variables within the emergency and observe bystander responses (Hornstein, Fisch, & Holmes, 1968; Piliavin & Piliavin, 1972; Piliavin, Rodin, & Piliavin, 1969).

Brown, Flint, and Fuqua (2014) conducted a field study examining how nutrition information affected vending machine purchases on a university campus. They identified five high-use machines and recorded purchases before the study began. Then, they placed colored stickers by each selection with red indicating less-healthy items, yellow for moderately healthy, and green for more-healthy items. Purchases after the stickers were added showed a significant increase for green sticker items and a decrease for red and yellow sticker items. Apparently, nutrition matters, at least for university students.

Advantages and Disadvantages of Simulation and Field Studies

Although simulation and field studies can be used to increase the realism of experiments, there are risks as well as advantages to these techniques. The obvious advantage of both procedures is that they allow researchers to investigate behavior in more lifelike situations and, therefore, should increase the chances that the experimental results accurately reflect natural events. The disadvantage of both procedures is that allowing nature to intrude on an experiment means that the researcher often loses some control over the situation and risks compromising the internal validity of the experiment. This problem is particularly important for field experiments for which researchers have no control over the "participants" who show up. Simulation experiments, on the other hand, do provide researchers with the opportunity to control the assignment of participants to treatment conditions. However, simulation experiments are totally dependent on the participants' willingness to accept the simulation. No matter how realistic the simulation, participants still know that it is only an experiment and they know that their behaviors are being observed. This knowledge could influence behavior and compromise the experimental results.

LEARNING CHECK

1. A researcher moves an experiment out of the laboratory and into the real world. This type of research is called
   a. a simulation study.
   b. a field study.
   c. a transported study.
   d. a quasi-experimental study.
2. Researchers often use simulation experiments in an attempt to obtain the __________ of an experiment and still keep much of the __________ of research conducted in the real world.
   a. external validity, internal validity
   b. internal validity, external validity
   c. experimental realism, mundane realism
   d. mundane realism, experimental realism
3. Although field studies tend to have higher external validity than traditional laboratory studies, what risk do they tend to have?
   a. Lower internal validity
   b. Lower reliability
   c. An increased risk of confounding from history effects
   d. An increased risk that the manipulation of the independent variable will not be effective.

Answers appear at the end of the chapter.

CHAPTER SUMMARY

At this point you should review the learning objectives presented at the beginning of each section and be sure that you have mastered each objective.

In general, an experiment attempts to demonstrate that changes in one variable are directly responsible for changes in a second variable. The two basic characteristics that distinguish the experimental research strategy from other research strategies are (1) manipulation of one variable while measuring a second variable and (2) control of extraneous variables. In an experiment, the independent variable is manipulated by the researcher, the dependent variable is measured for changes, and all other variables are controlled to prevent them from influencing the results.

To establish an unambiguous causal relationship between the independent and dependent variables, it is necessary to eliminate the possible influence of a confounding variable. Extraneous variables become confounds when they change systematically along with the independent variable. After identifying a short list of extraneous variables that have the potential to become confounding variables, it is possible to actively or passively control these variables. The two standard methods of active control are (1) holding a variable constant and (2) matching values across the treatment conditions. The method for passive control is to randomize variables across the treatment conditions.

An experiment always involves comparison of measures of the dependent variable across different levels of the independent variable. To accomplish this, a treatment condition (an experimental condition) and a no-treatment condition (a control condition) often are created. The no-treatment condition serves as a baseline for evaluating the effect of the treatment. There are two general categories of control conditions: (1) the no-treatment control condition, a condition that involves no treatment whatsoever (participants receive a zero level of the independent variable); and (2) the placebo control condition, a condition that involves the appearance of a treatment but from which the active, effective elements have been removed.

In an experiment, a researcher always manipulates the independent variable. Occasionally, a researcher may include a manipulation check to assess whether the participants are aware of the manipulation. A manipulation check is an additional measure to assess whether the manipulation was successful. It is particularly useful to use a manipulation check when participant manipulations, subtle manipulations, simulations, or placebo control conditions are used.

To establish a cause-and-effect relationship between two variables, an experiment necessarily creates an artificial, controlled environment in which the two variables being studied are isolated from outside influences. This high level of control required by an experiment can be a threat to external validity. To gain higher external validity, a researcher may use a simulation or a field study. A simulation involves creating a real-world atmosphere in a laboratory to duplicate a natural environment or situation; a field study involves moving an experiment from the laboratory into the real-world environment.

KEY WORDS

experimental research strategy
experiment, or true experiment
independent variable
treatment condition
levels
dependent variable
extraneous variables
manipulation
randomization
random assignment
experimental condition
control condition
no-treatment control condition
placebo effect
placebo control condition
manipulation check
simulation
field study

EXERCISES

The exercises are identified with specific learning objectives and are intended to assess your mastery of the objectives. You should be aware that exam items are also generated to assess learning objectives.

1. In addition to the key words, you should also be able to define the following terms:
   third-variable problem
   directionality problem
   confounding variable
   random process
   placebo
   mundane realism
   experimental realism
2. (**LO1**) Dr. Jones conducted a study examining the relationship between the amount of sugar in a child's diet and the activity level of the child. A sample of thirty 4-year-old children from a local preschool was used in the study. Sugar consumption was measured by interviewing the parents about each child's diet. Based on the result of the interview, each child was then placed into one of two groups: high sugar consumption and low sugar consumption. Activity level was measured by observing the children during a regular preschool afternoon. Finally, Dr. Jones compared the activity level for the high-sugar group with the activity level for the low-sugar group. Explain why Dr. Jones's study is not an example of the experimental research strategy.
3. (**LO2**) In an experiment examining human memory, two groups of participants are used. One group is allowed 5 minutes to study a list of 40 words and the second group is given 10 minutes of study time for the same list of words. Then, both groups are given a memory test, and the researcher records the number of words correctly recalled by each participant. For this experiment, identify the independent variable and the dependent variable.

4. (**LO3**) It has been demonstrated that students with high self-esteem tend to have higher grades than students with low self-esteem. Does this relationship mean that higher self-esteem causes better academic performance? Does it mean that better academic performance causes higher self-esteem? Explain your answer, and identify the general problem that can preclude a cause-and-effect explanation.
5. (**LO3**) A researcher would like to compare two methods for teaching math to third-grade students. Two third-grade classes are obtained for the study. Mr. Jones teaches one class using method A, and Mrs. Smith teaches the other class using method B. At the end of the year, the students from the method-B class have significantly higher scores on a mathematics achievement test. Does this result indicate that method B causes higher scores than method A? Explain your answer, and identify the general problem that precludes a cause-and-effect explanation.
6. (**LO2** and **6**) Define *extraneous variable* and explain how extraneous variables can become confounding variables.
7. (**LO4** and **5**) Identify the two characteristics needed for a research study to qualify as an experiment.
8. (**LO7**) Identify the two active methods of preventing extraneous variables from becoming confounding variables.
9. (**LO7**) Explain how the process of randomly assigning participants to treatment conditions should prevent a participant variable such as age or gender from becoming a confounding variable.
10. (**LO8**) Can a research study be an experiment without a control group? Can a study be an experiment without controlling extraneous variables?
11. (**LO9**) What is the general purpose of a manipulation check?
12. (**LO10**) What is the general purpose for using a simulation or a field study for experimental research?

LEARNING CHECK ANSWERS

Section 7.1
1. a, 2. d, 3. a

Section 7.2
1. c, 2. b, 3. b

Section 7.3
1. b, 2. a, 3. d

Section 7.4
1. a, 2. a, 3. d

Section 7.5
1. b, 2. b, 3. a