PART I

INTRODUCTION AND DESCRIPTIVE STATISTICS

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1 INTRODUCTION TO STATISTICS

LEARNING OBJECTIVES

After reading this chapter, you should be able to

LO 1.1	Define statistics and explain why it is important to understand.
LO 1.2	Distinguish between descriptive and inferential statistics, samples and populations, and sample statistics and population parameters.
LO 1.3	Describe three research methods commonly applied in the behavioral sciences: experimental, quasi-experimental, and correlational.
LO 1.4	State the four scales of measurement and identify examples of each.
LO 1.5	Distinguish between variables that are qualitative or quantitative and discrete or continuous.
SPSS LO 1.6	Enter data into SPSS by placing each group in separate columns and each group in a single column (coding is required).

Are you curious about the world around you? Do you think that seeing is believing? When something seems too good to be true, are you critical of the claims? If you answered yes to any of these questions, the next step in your quest for knowledge is to learn about the basis upon which we understand events and behaviors—specifically, ways in which scientists acquire knowledge. Much of what you think you know is actually based on the analyses scientists use to answer questions and "crunch the numbers" so that the numbers themselves make more sense or are more meaningful.

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

This book reveals the details of analysis and how scientists crunch the numbers, which will enable you to be a more critical consumer of knowledge by being able to critically evaluate the analyses that lead to the claims you come across each day. Understanding the various strengths and limitations of analysis in science can empower you to make educated decisions and confidently negotiate the many supposed truths in nature. You do not need to be a scientist to appreciate what you learn in this book. *Science* is all around you; for this reason, being a critical consumer of the information you come across each day is useful and necessary across professions.

1.1 THE USE OF STATISTICS IN SCIENCE

LO 1.1	Define statistics and explain why it is important to understand.

Why should you study statistics? The topic can be intimidating, and rarely does anyone tell you, "Oh, that's an easy course . . . take statistics!" **Statistics** is a branch of mathematics used to summarize, analyze, and interpret a group of numbers or observations—to make sense or meaning of our observations. For example, we can make sense of how good a soccer player is by observing how many goals they score each season, and we can understand climates by looking at average temperature. We can also understand change by looking at the same statistics over time—such as the number of goals scored by a soccer player in each game and the average temperature over many decades.

Statistics is commonly applied to evaluate scientific observations. Scientific observations are all around you. Whether you are making decisions about what to eat (based on health statistics) or how much to spend (based on the behavior of global markets), you are making decisions based on the statistical evaluation of scientific observations. Scientists who study human behavior gather information about all sorts of behavior of interest to them, such as information on addiction, happiness, worker productivity, resiliency, faith, child development, love, and more. The information that scientists gather is evaluated in two ways:

- Scientists organize and summarize information so that the information is meaningful to those who read about the observations scientists made in a study. This type of evaluation of information is called *descriptive statistics*.
- Scientists use information to answer a question (e.g., Is diet related to obesity?) or make an actionable decision (e.g., Should we implement a public policy change that can reduce obesity rates?). This type of evaluation of information is called *inferential statistics*.

This book describes how to apply and interpret both types of statistics in science and in practice to make you a more informed interpreter of the statistical information you encounter inside and outside of the classroom. For a review of statistical notation (e.g., summation notation) and a basic math review, refer to Appendix B. Descriptive statistics is discussed in Chapters 2–4 and applications for probability are further introduced in Chapters 5–7; the discussion of inferential statistics is found in Chapters 8–18.

The reason it is important to study statistics can be described by the words of Mark Twain: *There are lies, damned lies, and statistics.* He meant that statistics can be deceiving, and so can interpreting them. Statistics are all around you—from your college grade point average (GPA) to a *Newsweek* poll predicting how many votes political candidates will get in an election. In each case, statistics are used to inform you. The challenge as you move into your careers is to be able to identify statistics and to interpret what they mean. Statistics are generally important because they are part of your everyday life, and they are subject to interpretation. The interpreter, of course, is *you*.

In many ways, statistics allow a story to be told. For example, your GPA may reflect the story of how well you are doing in school; the *Newsweek* poll may tell the story of which candidate is likely to win an election. There are many ways to tell a story. Similarly, in statistics, there are many ways to evaluate the information gathered in a study. Understanding statistics is important because it will enable you to be a critical consumer of the information you come across, which includes information that is scientific. In this book, you will learn the fundamentals of statistical evaluation, which can help you to critically evaluate any information presented to you.

In this chapter, we begin by introducing the two general types of statistics identified here:

- Descriptive statistics: applying statistics to organize and summarize information
- Inferential statistics: applying statistics to interpret the meaning of information

LEARNING CHECK 1.1

1. ______ is a branch of mathematics used to summarize, analyze, and interpret a group of numbers or observations. [Fill in the blank]
   a. Statistics
   b. Research
   c. Science

2. Statistics can be used to summarize information or be applied to evaluate or answer questions.
   a. True
   b. False
3. Which of the following best explains why it is important to understand statistics?
   a. Statistics are important because they are part of our everyday life, and they are subject to interpretation.
   b. Statistics are important because they enable us to be critical consumers of the information we come across every day.
   c. Both a and b.

Answers: 1. a; 2. a; 3. c.

1.2 DESCRIPTIVE AND INFERENTIAL STATISTICS

LO 1.2 Distinguish between descriptive and inferential statistics, samples and populations, and sample statistics and population parameters.

The research process typically begins with a question or statement that can only be answered or addressed by making an observation. The observations researchers make are typically recorded as numeric values called *data*. The term **data** is plural, meaning a set of scores, measurements, or observations that are typically numeric. In contrast, **datum** is singular, referring to a single measurement or observation; it is also called a **score** or **raw score**.

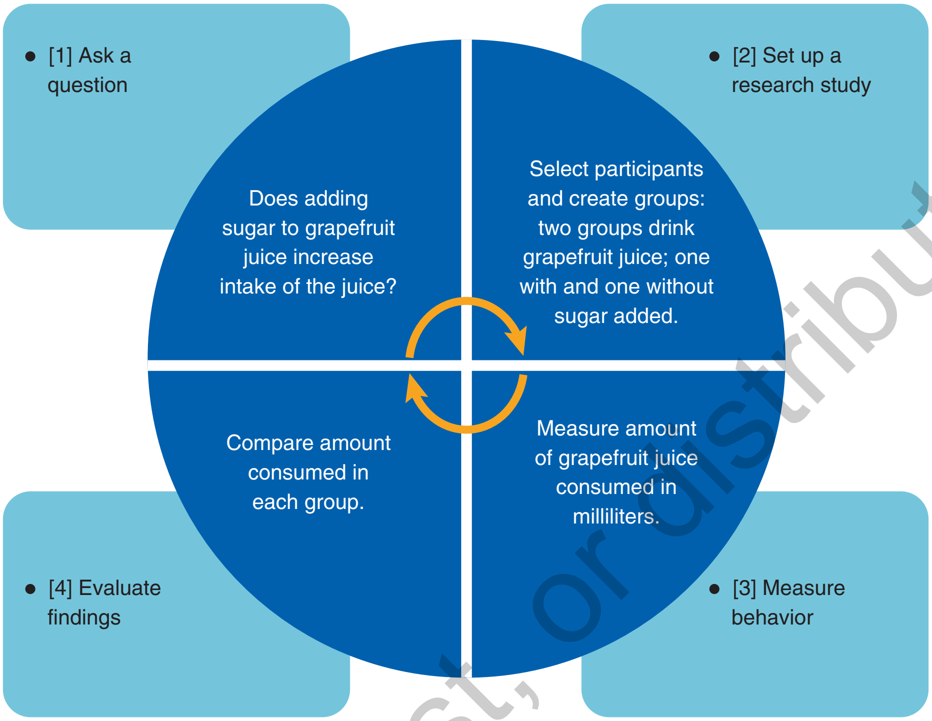
To illustrate the general structure for making scientific observations, Figure 1.1 lays out a basic example adapted from studies that evaluate making healthy food choices, such as increasing intake of healthy fruits (Lee et al., 2019; Privitera, 2016; Sharma et al., 2016). In this example, suppose a researcher asks whether adding sugar to a sour-tasting fruit juice (a grapefruit juice) can increase intake of this healthy juice. To test this question, the researcher first identifies a group of participants who dislike plain grapefruit juice and sets up a research study to create two groups: Group No Sugar (this group drinks the grapefruit juice without any added sugar) and Group Sugar (this group drinks the grapefruit juice with sugar added). In this study, the researcher measures intake (i.e., how much juice is consumed). Suppose they decide to measure amount consumed in milliliters (30 milliliters equals about 1 ounce). The data in this example are the volume of drink consumed in milliliters. If adding sugar increases intake of grapefruit juice, then we expect that participants will consume more of the grapefruit juice when sugar is added (i.e., Group Sugar will consume more milliliters of the juice than Group No Sugar).

In this section, we will introduce how descriptive and inferential statistics allow researchers to assess the data they measure in a research study, using the example given here and in Figure 1.1.

Descriptive Statistics

One way in which researchers apply statistics in research is by using **descriptive statistics**, which are procedures used to summarize, organize, and make sense of a set of scores called data. Descriptive statistics are typically presented graphically, in tabular form (in tables), or as summary statistics (single values). These procedures are most often used to quantify the behaviors researchers measure. Thus, we measure or record data (e.g., milliliters consumed), then use descriptive statistics to summarize or make sense of those data, which describe the phenomenon of interest (e.g., intake of a healthy fruit juice). In our example, *intake* could

FIGURE 1.1 ■ General Structure for Making Scientific Observations



The general structure for making scientific observations, using an example for testing whether adding sugar increases intake of grapefruit juice.

be described simply as "amount consumed," but that does not describe it numerically—or in a way that allows us to record data on intake. So instead, we stated that intake is "milliliters consumed" of the juice; hence, intake can now be measured. If we observe hundreds of participants, the data in a spreadsheet would be overwhelming. Presenting a spreadsheet with the intake for each individual participant is not very clear. For this reason, researchers use descriptive statistics to summarize sets of individual measurements so they can be clearly presented and interpreted.

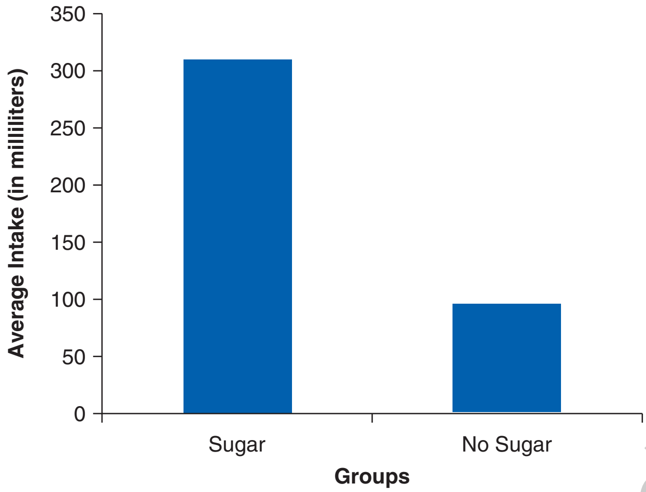
Data are generally presented in summary. Typically, this means that data are presented graphically, in tabular form (in tables), or as summary statistics (e.g., an average). For example, instead of listing each individual measure of intake, we could summarize the average (mean), middle (median), or most common (mode) amount consumed in milliliters among all participants, which can be more meaningful.

Tables and graphs serve a similar purpose to summarize both large and small sets of data. One particular advantage of tables and graphs is that they can clarify findings in a research study. For example, to evaluate the findings for our study, we expect that participants will consume more grapefruit juice in milliliters if sugar is added to the juice. Figure 1.2 displays these expected findings. Notice how summarizing the average intake in each group in a figure can clarify research findings.

Inferential Statistics

Most research studies include only a select group of participants, and do not include all participants who are members of a particular group of interest. In other words, most scientists have limited access to the phenomena they study. To accommodate this, researchers select a

FIGURE 1.2 ■ Summary of Expected Findings



A graphical summary of the expected findings if adding sugar increases intake of grapefruit juice.

portion of all members of a group (the *sample*) when they do not have access to all members of a group (the *population*). Imagine, for example, observing every person who is attending college, or is serving in the military, or is taking a statistics class—each is an example of a population of interest. However, in most cases and for most phenomena, the population of interest is likely too large to observe. Because it is often not possible to observe all individuals in a population, researchers require statistical procedures, called **inferential statistics**, which allow them to generalize observations made with samples to the larger population from which they were selected. Specifically, inferential statistics allow us to infer that observations made with a sample are also likely to be observed in the larger population from which the sample was selected.

To illustrate, we can continue with the grapefruit juice study. If we are interested in all those who have a general dislike for sour-tasting grapefruit juice, then this group would constitute the population of interest. A **population** is the set of all individuals, items, or data of interest. This is the group about which scientists will generalize. In our example, we want to test whether adding sugar increases intake of grapefruit juice in this population; this characteristic (intake of grapefruit juice) in the population is called a **population parameter**, which is a characteristic (usually numeric) that describes a population. Intake, then, is the characteristic we will measure, but not in the population. In practice, researchers do not have access to an entire population. They simply do not have the time, money, or other resources to even consider studying all those who have a general dislike for sour-tasting grapefruit juice.

An alternative to selecting all members of a population is to select a portion or sample of individuals in the population. A **sample** is a set of individuals, items, or data selected from a population of interest. Selecting a sample is more practical, and most scientific research is based upon findings in samples, not populations. In our example, we can select any portion of those who have a general dislike for sour-tasting grapefruit juice from the larger population; the portion of those we select will constitute our sample. A characteristic that describes a sample, such as intake of grapefruit juice, is called a **sample statistic**. A sample statistic is measured to estimate what this value may be for the corresponding population parameter. In this way, a sample is selected from a population to learn more about the characteristics of the population of interest.

MAKING SENSE

POPULATIONS AND SAMPLES

A population is identified as any group of interest, whether that group is all students worldwide or all students in a professor's class. Think of any group you are interested in. Maybe you want to understand why college students join fraternities and sororities. So students who join fraternities and sororities is the group you are interested in. Hence, to you, this group is a population of interest.

Remember that researchers select samples only because they do not have access to all individuals in a population. Imagine having to identify every person who has fallen in love, experienced anxiety, been attracted to someone else, suffered with depression, or taken a college exam. It is ridiculous to consider that we can identify all individuals in such populations. So researchers use data gathered from samples (a portion of individuals from the population) to make inferences concerning a population.

To make sense of this, suppose you want to get an idea of how people in general feel about a new pair of shoes you just bought. To find out, you put your new shoes on and ask 20 people at random throughout the day whether or not they like the shoes. Now, do you really care about the opinion of only those 20 people you asked? Not really—you actually care more about the opinion of people in general. In other words, you only asked the 20 people (your sample) to get an idea of the opinions of people in general (the population of interest). Sampling from populations follows a similar logic.

Example 1.1 applies the process of sampling to distinguish between a sample and a population.

EXAMPLE 1.1

In the following example, we will identify the population, sample, population parameter, and sample statistic: Suppose you read an article in the local college newspaper citing that the average college student plays 2 hours of video games per week. To test whether this is true for your school, you randomly approach 20 fellow students and ask them how long (in hours) they play video games per week. You find that the average student, among those you asked, plays video games for 1 hour per week. Distinguish the population from the sample.

In this example, all college students at your school constitute the population of interest, and the 20 students you approached is the sample that was selected from this population of interest. Because it is purported that the average college student plays 2 hours of video games per week, this is the population parameter (2 hours). The average number of hours playing video games in the sample is the sample statistic (1 hour).

LEARNING CHECK 1.2

1. ______ are procedures used to summarize, organize, and make sense of a set of scores called data. [Fill in the blank]
   a. Inferential statistics
   b. Descriptive statistics

2. ______ describe(s) characteristics in a population, whereas ______ describe(s) characteristics in a sample. [Fill in the blanks]
   a. Statistics; parameters
   b. Inferential; descriptive
   c. Descriptive; inferential
   d. Parameters; statistics
3. A psychologist is interested in studying 40 students at a local private school. If the psychologist selects the entire population of interest for this study, how many students are included?
   a. 40 students
   b. less than 40 students
   c. more than 40 students
   d. all public school students
4. Inferential statistics are used to help researchers make inferences about unknown parameters in a given population.
   a. True
   b. False

Answers: 1. b; 2. d; 3. a; 4. a.

1.3 RESEARCH METHODS AND STATISTICS

LO 1.3 Describe three research methods commonly applied in the behavioral sciences: experimental, quasi-experimental, and correlational.

In this book, we describe many ways of measuring and interpreting data. Yet, simply collecting data does not make you a scientist. **Science** is the study of phenomena, such as behavior, through strict observation, evaluation, interpretation, and theoretical explanation. To engage in science, then, you must follow specific procedures for collecting data. Think of this as playing a game. Without the rules and procedures for playing, the game itself would be lost. The same is true in science; without the rules and procedures for collecting data, the ability to draw scientific conclusions would be lost.

To illustrate further the basic premise of engaging in science, suppose you come across the following problem first noted by the famous psychologist Edward Thorndike in 1898:

> Dogs get lost hundreds of times and no one ever notices it or sends an account of it to a scientific magazine, but let one find his way from Brooklyn to Yonkers and the fact immediately becomes a circulating anecdote. Thousands of cats on thousands of occasions sit helplessly yowling, and no one takes thought of it or writes to his friend, the professor; but let one cat claw at the knob of a door supposedly as a signal to be let out, and straightway this cat becomes the representative of the cat-mind in all books. . . . In short, the anecdotes give really . . . supernormal psychology of animals. (pp. 4–5)

Here the problem was to determine the animal mind. Thorndike posed the question of whether animals were truly smart, based on the many observations he made. This is where the scientific process typically begins: with a question. To answer questions in a scientific manner, however, we need more than just statistics; we need a set of procedures for making observations and measurements. These procedures, called the **research method** or **scientific method**, are systematic techniques used to acquire, modify, and integrate knowledge concerning observable and measurable phenomena.

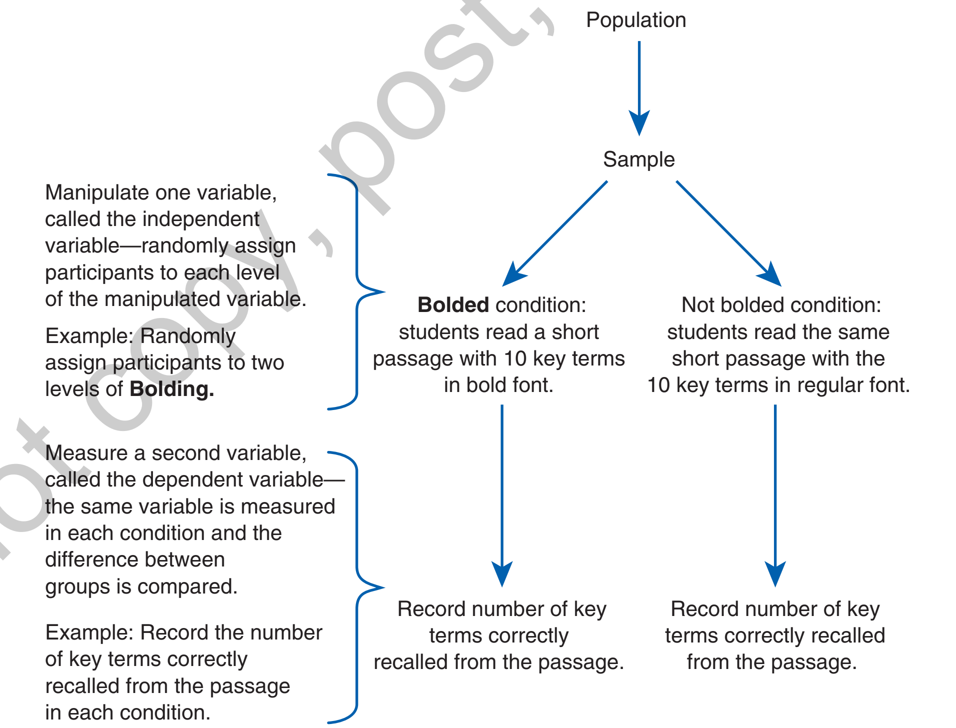
In this section, we introduce three research methods that are commonly applied in the behavioral sciences (these methods will be applied throughout the book):

- Experimental method
- Quasi-experimental method
- Correlational method

Experimental Method

Often, the aims of a researcher are to demonstrate a causal relationship (i.e., that one variable causes changes in another variable). A study that can demonstrate cause is called an *experiment*. To demonstrate cause, though, an experiment must follow strict procedures to ensure that all other possible causes are eliminated or highly unlikely. Hence, researchers must control the conditions under which observations are made in order to isolate cause-and-effect relationships between variables. In this light, an **experimental method** is applied to make observations in which a researcher fully controls the conditions and experiences of participants by applying three required elements of control (manipulation, randomization, and comparison/control) to isolate cause-and-effect relationships between variables. Figure 1.3 shows the general structure of an experiment.

FIGURE 1.3 ■ The Basic Structure of an Experiment



The basic structure of an experiment that meets each requirement for demonstrating cause and effect. A sample of students at a similar reading level was selected at random from a population of college undergraduates to test whether bolding key terms in a short passage improves recall. To qualify as an experiment, (1) the researcher created each level of the bolding/not bolding independent variable (manipulation), (2) students were randomly assigned to read a passage with or without bolded key terms (randomization), and (3) a control group was present in which the manipulation of bolding the key terms was absent (comparison/control).

Figure 1.3 illustrates a basic example adapted from larger-scale studies looking at metacognition and memory recall (Murphy & Castel, 2021; Shea, 2019). Here we evaluate whether writing key terms in bold (just like we do in this book in each chapter) improves recall of those words. A sample of students at a similar reading level was selected from a population of college undergraduates. In one group, students read a short passage with 10 bolded key terms; in the other group, students read the same short passage but with the 10 key terms in regular font. After reading each passage, students were asked to write down as many key terms as they could recall. The number of correct key terms listed was recorded for each group.

For this study to be called an experiment, researchers must satisfy three requirements. These requirements are regarded as necessary steps to ensure enough control to allow researchers to draw cause-and-effect conclusions:

1. Manipulation (of variables that operate in an experiment)
2. Randomization (of assigning participants to conditions)
3. Comparison/control (a control group)

To meet the requirement of randomization, researchers must use **random assignment**, which is a procedure used to ensure that participants in a study have an equal chance of being assigned to a particular group or condition (Requirement 2). To do this, a researcher must be able to manipulate the levels of an independent variable (Requirement 1) to create the groups. An **independent variable (IV)** is the variable that is manipulated in an experiment. This variable remains unchanged (or "independent") between conditions being observed in an experiment. In Figure 1.3, the independent variable was bolding. The **levels of the independent variable** are the specific conditions or groups of an independent variable. In this case, the independent variable, bolding, has two levels: bolded and regular font. The researcher first manipulated the levels of this variable (bolded, regular font), meaning that they created the conditions. They then assigned students at a similar reading level at random to experience one of the levels of font type. As an example of random assignment, the researcher could select participant names at random from names written on pieces of paper in a bowl—with every other participant name selected assigned to the experimental (bold font) group and all others to the control group (regular font group).

Random assignment and manipulation ensure that characteristics of participants in each group (such as their age, intelligence level, or study habits) vary entirely by chance. Because participant characteristics in both groups now occur at random, we can assume that these characteristics are about the same in both groups. This makes it more likely that any differences observed between groups were caused by the manipulation (bolded vs. regular font key terms in a passage) and not by participant characteristics.

Notice also that there are two groups in the experiment shown in Figure 1.3. The number of correct key terms listed after reading the passage was recorded and can be compared in each group. By comparing the number of correct key terms listed in each group, we can determine whether bolding the key terms caused better recall of the key terms compared to those who read the same passage without bolded key terms. This satisfies the requirement of comparison (Requirement 3), which requires that at least two groups be observed in an experiment so that scores in one group can be compared to those in at least one other group.

In this example, recall of key terms was recorded in each group. The variable that is recorded or measured in each group is called the **dependent variable (DV)**; it is the "presumed effect" or the variable believed to change in the presence of the independent variable. Dependent variables can often be measured in many ways, and therefore they often require an **operational definition**. An operational definition is a description of some observable event in terms of the specific process or manner by which it was observed or measured. In other words, it is a description of how a dependent variable was measured in an experiment. For example, here we operationally defined *recall* as the number of key terms correctly listed after reading a passage (students could recall 0 to all 10 key terms). Thus, we measured the dependent variable as a number. To summarize the experiment in Figure 1.3, bolding key terms (IV) was presumed to cause an effect or difference in recall (DV) between groups. This is an experiment in which the researcher satisfied the requirements of manipulation, randomization, and comparison/control, thereby allowing them to draw cause-and-effect conclusions, assuming the study was properly conducted.

MAKING SENSE

EXPERIMENTAL AND CONTROL GROUPS

Although a comparison group is sometimes necessary, it is preferred that, when possible, a control group be used. By definition, a control group must be treated exactly the same as an experimental group, except that the members of this group do not actually receive the treatment believed to cause changes in the dependent variable. As an example, suppose we hypothesize that rats will dislike flavors that are associated with becoming ill (Chambers, 2018; Garcia et al., 1955). To test this hypothesis, the rats in an experimental group receive a vanilla-flavored drink followed by an injection of lithium chloride to make them ill. The rats in a control group must be treated the same, minus the manipulation of administering lithium chloride to make them ill. In a control group, then, rats receive the same vanilla-flavored drink also followed by an injection, but in this group the substance injected is inert, such as a saline solution (called a *placebo*). The next day, we record how much vanilla-flavored solution (in milliliters) rats consume during a brief test.

Note that simply omitting the lithium chloride is not sufficient. The control group in our example still receives an injection; otherwise, both being injected and the substance that is injected will differ between groups. It is also important to ensure that other environmental factors are the same for all rats, such as their day-night sleep cycles and housing arrangements and the food they consume before and during the study. These added levels of control ensure that both groups are truly identical, except that one group is made ill and a second group is not. In this way, researchers can isolate all factors in an experiment, such that only the manipulation that is believed to cause an effect is different between groups. This same level of consideration must be made in human experiments to ensure that groups are treated the same, except for the factor that is believed to cause changes in the dependent variable.

Quasi-Experimental Method

Suppose we hypothesize that high school graduates who attend college will value an education more than those who do not attend college. To test this hypothesis, we could select a sample of high school graduates from the same graduating class and divide them into two groups: those who attended college (Group College) and those who did not attend college (Group No College). We could then have all participants complete a survey in which higher scores on the survey indicate a higher value placed on obtaining an education. If the hypothesis is correct and we set up this study correctly, then participants in Group College should show higher scores on the survey than participants in Group No College.

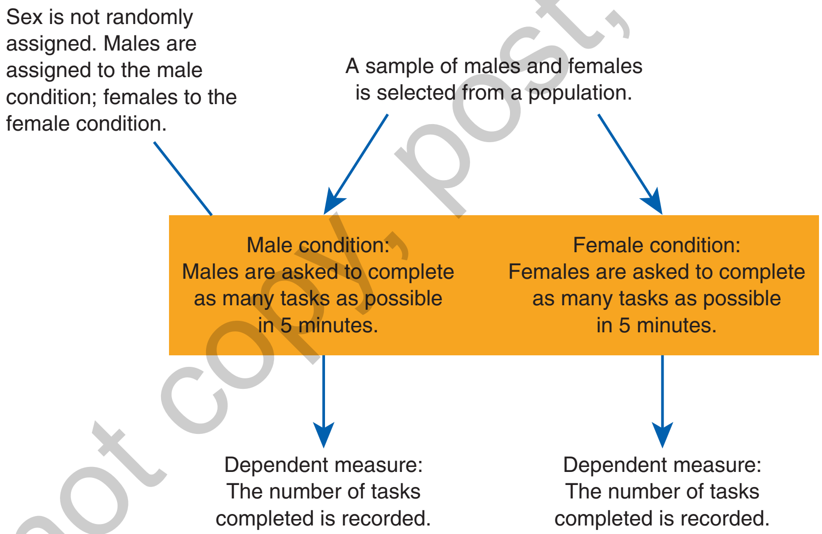
Notice in this example that participants controlled which group they were assigned to—they either attended college or did not. The variable of interest was preexisting, or inherent to the participants themselves (i.e., whether or not they attended college). Hence, this example lacks the control required for an experiment (i.e., it lacks manipulation and random assignment), and is therefore a quasi-experiment. A **quasi-experimental method** is applied to make observations in a study that is structured like an experiment but has conditions and experiences of participants that lack some control because the study

1. lacks random assignment,
2. includes a preexisting variable (i.e., a variable that is not manipulated), and/or
3. does not include a comparison/control group.

In a quasi-experiment, the variable that is not manipulated and/or the levels to which participants are not randomly assigned is called a **quasi-independent variable**. A quasi-independent variable is also called a **factor**, which is a term used to describe any type of variable—whether independent or quasi-independent. The **levels of the factor** are the specific conditions or groups of an independent or quasi-independent variable; these levels differentiate the groups or conditions being compared in a research study.

Figure 1.4 illustrates a quasi-experiment with a quasi-independent variable or factor (sex) with two levels (male, female) comparing differences in multitasking (the dependent variable). Because participants cannot be randomly assigned to the levels of sex (male, female), sex is a quasi-independent variable, and this study is therefore regarded as a quasi-experiment.

FIGURE 1.4 ■ The Basic Structure of a Quasi-Experiment



In this example, researchers measured differences in multitasking behavior by sex. The grouping variable (sex) is preexisting. That is, participants were already male or female prior to the study. For this reason, researchers cannot manipulate the variable or randomly assign participants to each level of sex, so this study is regarded as a quasi-experiment.

A study is also regarded as a quasi-experiment when only one group is observed. With only one group, there is no comparison or control group, which means that differences between two levels of a factor cannot be compared. In this way, failing to satisfy any of the requirements for an experiment makes the study a quasi-experiment when the study is otherwise structured similarly to an experiment.

Correlational Method

Another method for examining the relationship between variables is to measure pairs of scores for each individual, called the correlational method. The **correlational method** is the measurement of two or more factors to determine or estimate the extent to which the values for the factors are related or change in an identifiable pattern. In other words, we can use this method to determine whether a relationship exists between variables. However, it lacks the appropriate controls needed to demonstrate cause and effect.

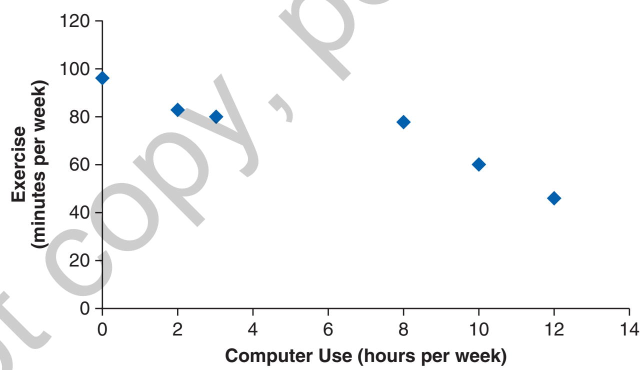
To illustrate the correlational method, suppose we test for a relationship between time spent using a computer and exercising per week. The data for such a study appear in tabular form and are plotted as a graph in Figure 1.5. Using the correlational method, we can examine the extent to which two variables change in a related fashion. In the example shown in Figure 1.5, as computer use increases, time spent exercising decreases. This pattern suggests that computer use and time spent exercising are related.

FIGURE 1.5 ■ An Example of the Correlational Method

(a)

Participant	Computer use (Hours per week)	Exercise (Minutes per week)
A	3	80
B	2	83
C	0	96
D	10	60
E	8	78
F	12	46

(b)



In this example, researchers measured the amount of time students spent using the computer and exercising each week. (a) The table shows two sets of scores for each participant. (b) The graph shows the pattern of the relationship between these scores. From the data, it is apparent that as computer use increases, time spent exercising decreases. Hence, the two factors change in a related pattern.

Notice that no variable is manipulated to create different conditions or groups to which participants can be randomly assigned. Instead, two variables are measured for each participant, and the extent to which those variables are related is measured. Thus, the correlational method does not control the conditions under which observations are made and is therefore not able to demonstrate cause-and-effect conclusions. This book describes many statistical procedures used to analyze data using the correlational method (Chapters 15–17) and the experimental and quasi-experimental methods (Chapters 8–14 and 17–18).

Example 1.2 applies a research example to identify how a research design can be constructed.

EXAMPLE 1.2

A researcher conducts the following study: Participants are presented with a list of words written on a white background on a PowerPoint slide. In one group, the words are written in red (Group Red); in a second group, the words are written in black (Group Black). Participants are allowed to study the words for 1 minute. After that time, the slide is removed, and participants are allowed 1 minute to write down as many words as they can recall. The number of words correctly recalled will be recorded for each group. Explain how this study can be an experiment.

To create an experiment, we must satisfy the three requirements for demonstrating cause and effect: manipulation, randomization, and comparison. To satisfy each requirement, the researcher can

1. Randomly assign participants to experience one of the conditions—this ensures that some participants read red words and others read black words entirely by chance;
2. Create the two conditions that are identical, except for the color manipulation—the researcher can write the same 20 words on two PowerPoint slides, on one slide in red and on the second slide in black; and
3. Include a comparison group—in this case, the number of red words correctly recalled will be compared to the number of black words correctly recalled, so this study has a comparison group.

Remember that each requirement is necessary to demonstrate that the levels of an independent variable are causing changes in the value of a dependent variable. If any one of these requirements is not satisfied, then the study is not an experiment.

LEARNING CHECK 1.3

1. ______ is the study of phenomena through strict observation, evaluation, interpretation, and theoretical explanation. [Fill in the blank]
   a. Science
   b. Randomization
   c. Generalization

For questions 2-4, state the type of research design described in each example. Answer E for an experiment, Q for a quasi-experiment, or C for a correlational method.

2. A researcher tests whether the dosage level of some drug (low, high) causes significant differences in health.
3. A researcher tests whether married couples with and without children show differences in attitudes toward spanking.
4. A researcher measures the relationship between annual income and life satisfaction.

Answers: 1. a; 2. E; 3. Q; 4. C.

1.4 SCALES OF MEASUREMENT

LO 1.4 State the four scales of measurement and identify examples of each.

Many statistical tests introduced in this book require that variables in a study be measured on a certain scale. In the early 1940s, Harvard psychologist S. S. Stevens coined the terms *nominal, ordinal, interval*, and *ratio* to classify the scales of measurement (Stevens, 1946). The **scales of measurement** are rules identifying how the properties of numbers can change with different uses. These rules imply that the extent to which a number is informative depends on how it was used or measured. In this section, we discuss the extent to which data are informative on each scale of measurement. In all, scales of measurement are characterized by three properties: order, difference, and ratio. Each property can be described by answering the following questions:

1. *Order*: Does a larger number indicate a greater value than a smaller number?
2. *Difference*: Does subtracting two numbers represent some meaningful value?
3. *Ratio*: Does dividing (or taking the ratio of) two numbers represent some meaningful value?

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Table 1.1 gives the answers to the questions for each scale of measurement. In this section, we begin with the least informative scale (nominal) and finish with the most informative scale (ratio).

TABLE 1.1 ■ Scales of Measurement

		Scale of Measurement			
		Nominal	Ordinal	Interval	Ratio
Property	Order	No	Yes	Yes	Yes
	Difference	No	No	Yes	Yes
	Ratio	No	No	No	Yes

The four scales of measurement and the information they provide concerning the order, difference, and ratio of numbers.

Nominal Scales

Numbers on a **nominal scale** identify something or someone; they provide no additional information. Common examples of nominal numbers include ZIP codes, license plate numbers, credit card numbers, country codes, telephone numbers, and Social Security numbers. These numbers simply identify locations, vehicles, or individuals and nothing more. One credit card number, for example, is not greater than another; it is simply different.

In science, values on a nominal scale are typically categorical variables that, for the purpose of analysis, are coded—converted to numeric values. Specifically, **coding** is the procedure of converting a nominal or categorical variable to a numeric value. For example, nominal variables include a person's race, political affiliation, hair and eye color, marital status, gender, season of birth, and more. To apply coding, we can, for example, code gender as cisgender men = 1 and cisgender women = 2; we can code the seasons of birth as 1, 2, 3, and 4 for spring, summer, fall, and winter, respectively. These numbers are used to identify gender or the seasons and nothing more. Coding words with numeric values is useful for the purpose of analysis, particularly when entering names of groups for a research study into statistical programs such as SPSS because it can be easier to enter and analyze data when categories are entered as numbers, not words.

Ordinal Scales

An **ordinal scale** of measurement is one that conveys order or rank alone—it conveys only that some value is greater or less than another value. Examples of ordinal scales include finishing order in a competition, education level, and rankings. These scales only indicate that one value is greater than or less than another, so differences between ranks do not have meaning. Consider, for example, the *U.S. News & World Report* rankings for the top psychology graduate school programs in the United States. Table 1.2 shows the rank, college, and actual score for the top

TABLE 1.2 ■ Ordinal Scale Data for College Rankings

Rank	College Name	Actual Score
1	Stanford University	4.8
1	University of California, Berkeley	4.8
3	Harvard University	4.7
3	University of California, Los Angeles	4.7
3	University of Michigan, Ann Arbor	4.7
3	Yale University	4.7
7	University of Illinois at Urbana-Champaign	4.5
8	Massachusetts Institute of Technology	4.4
8	Princeton University	4.4
8	University of Minnesota, Twin Cities	4.4
8	University of Pennsylvania	4.4
8	University of Texas at Austin	4.4
13	University of California, San Diego	4.3
13	University of North Carolina at Chapel Hill	4.3
13	University of Wisconsin–Madison	4.3
13	Washington University in St. Louis	4.3
17	Carnegie Mellon University	4.2
17	Columbia University	4.2
17	Duke University	4.2
17	Indiana University–Bloomington	4.2
17	Northwestern University	4.2
17	University of Chicago	4.2
17	University of Virginia	4.2
24	Cornell University	4.1
24	The Ohio State University	4.1

A list of the *U.S. News & World Report* rankings for the top 25 psychology graduate school programs in the United States in 2017, including ties (left column), and the actual points used to determine their rank (right column).

Source: US News & World Report, https://www.usnews.com/best-graduate-schools/top-humanities-schools/psychology-rankings.

25 programs, including ties, in 2017. Based on ranks alone, can we say that the difference between the psychology graduate programs ranked 3 and 7 is the same as the difference between those ranked 13 and 17? No. In both cases, four ranks separate the schools. However, if you look at the actual scores for determining rank, you find that the difference between ranks 3 and 7 is 0.2 points, whereas the difference between ranks 13 and 17 is 0.1 point. Hence, the difference in points is not the same. Ranks alone do not convey this difference. They simply indicate that one rank is greater than or less than another rank.

Interval Scales

An **interval scale** of measurement has two defining principles: (1) values on this scale are (or are assumed to be) equidistant and (2) these values have no true zero. A common, yet somewhat controversial, example of this scale of measurement in the behavioral sciences is rating scales (refer to Figure 1.6). Rating scales are numeric response scales typically used to indicate a participant's level of agreement with or opinion of some statement. These scales are taught here as an interval scale of measurement because most researchers report these as interval data in published research (for a deeper discussion of this controversy, refer to MAKING SENSE—Treating Rating Scales as Interval Scale Measures). Here we will look at each defining principle of interval scales of measurement.

FIGURE 1.6 ■ An Example of a 7-Point Rating Scale for Satisfaction Used for Scientific Investigation

Satisfaction Ratings						
1	2	3	4	5	6	7
Completely Unsatisfied						Completely Satisfied

The first defining principle of an interval scale measure is that values on this scale are (or are assumed to be) equidistant. An **equidistant scale** is a scale or set of numbers with intervals or values distributed in equal units. Temperature, for example, is distributed in equal units or degrees. Another common example, as identified earlier, is rating scales. Many behavioral scientists make the assumption that scores on a rating scale are distributed in equal units. For example, if you are asked to rate your satisfaction with a spouse or job on a 7-point scale from 1 (completely unsatisfied) to 7 (completely satisfied), then you are using an interval scale, as shown in Figure 1.6. Assuming that the distance between each point (from 1 to 2; 2 to 3; 3 to 4, and so on) is the same or equal, it is appropriate to compute differences between scores on this scale. So a statement such as "The difference in job satisfaction among men and women was 2 points" is appropriate with interval scale measurements.

The second defining principle of an interval scale measure is that it has no true zero. For a scale to have a **true zero**, the value 0 must truly represent nothing or the absence of the phenomenon being measured. A common example of an interval scale with no true zero is temperature—for most measures of temperature, such as Fahrenheit or Celsius, values equal to zero do not mean that there is no temperature; it is just an arbitrary zero point. Indeed, 0 degrees Fahrenheit is quite cold in the winter. Measurements of latitude and longitude also fit this criterion of having no true zero. Another common example is values on a rating scale. In the example shown in Figure 1.6, 1 was used to indicate no satisfaction, not 0. Each value is arbitrary, even if 0 is included on the scale. That is, we could use any number to represent "no satisfaction." The implication is that without a true zero, there is no outright value to indicate the absence of the phenomenon you are observing (so a zero proportion is not meaningful). For this reason, stating a ratio such as "Satisfaction ratings were three times greater among men compared to women" is not appropriate with interval scale measurements.

Ratio Scales

Ratio scales are measurements that have a true zero and are distributed in equal units. Thus, ratio scales are similar to interval scales in that scores are distributed in equal units. Yet, unlike interval scales, a distribution of scores on a ratio scale has a true zero (0 represents nothing or the absence of the phenomenon being measured). This is an ideal or optimal scale in behavioral research because ratio scale measurements convey order, differences, and ratios. Common examples of ratio scales include measures of length, height, weight, and time. For scores on a ratio scale, order is informative. For example, a person who is 25 years old is older than a person who is 20 (they are 5 years older). Differences are also informative. For example, the difference between 70 and 60 seconds is the same as the difference between 30 and 20 seconds (the difference is 10 seconds). Ratios are also informative on this scale because a true zero is defined—0 truly means nothing. Hence, it is meaningful to state that 60 pounds is twice as heavy as 30 pounds.

In science, researchers often go out of their way to measure variables on a ratio scale. For example, if they measure hunger, they may choose to measure the amount of time between meals or the amount of food consumed (in ounces). If they measure memory, they may choose to measure the amount of time it takes to memorize some list or the number of errors made. If they measure depression, they may choose to measure the dosage (in milligrams) that produces the most beneficial treatment or the number of symptoms reported. In each case, the behaviors are measured using values on a ratio scale, thereby allowing researchers to draw conclusions in terms of order, differences, and ratios—there are no restrictions for interpreting outcomes using variables measured on a ratio scale.

MAKING SENSE

TREATING RATING SCALES AS INTERVAL SCALE MEASURES

In the published literature, rating scales—which are widely used in the behavioral sciences and even in clinical settings to diagnose behavioral disorders (Myers & Winters, 2002; Zimmerman et al., 2018)—are typically treated as interval scale measures. Rating scales can be measures of a single item, like in Figure 1.6 for satisfaction levels, or they can be a multi-item measure, with multiple items used to measure the same behavior. Multi-item scales, often preferred to single-item scales, are quite popular in the behavioral sciences. A classic example of a multi-item scale is the Rosenberg Self-Esteem Scale (Rosenberg, 1965), which has 10 items to assess self-esteem, with the total score of all 10 items representing an individual's level of self-esteem.

Researchers who treat rating scales as interval scale measures do so because (1) these measures have no true zero and (2) they assume that values on this scale are equidistant. The controversy comes, in large part, with asking whether it is appropriate to accept the assumption that values on these scales are equidistant. If the assumption is appropriate, then we can treat rating scales as interval scale measures; if the assumption is inappropriate, then rating scales would be ordinal scale measures at best (possibly nominal).

Those who advocate for treating rating scales as ordinal measures are often labelled *fundamentalists* (Nunnally, 1967, p. 20) in that they view appropriate measurement as being more explicit, objective, or "assumption free." In this light, fundamentalists view the assumption that values on these scales are equidistant as inappropriate. Those who advocate for treating rating scales as interval measures are often labelled *pragmatists* (Acock & Martin, 1974, p. 427) in that they view appropriate measurement as being more implicit, subjective, or "theoretical" in terms of allowing assumptions to be made based on the best judgements of researchers and the theories or hypotheses they test. In this light, pragmatists view the assumption that values on these scales are equidistant as appropriate.

So why does any of this matter? Why do so many researchers make the assumption that values on these scales are equidistant, thereby treating rating scales as interval scale measures? To answer this, think of statistics as tools in a toolbox. As researchers, we want as many tools available to us as possible in our toolbox. However, many statistical tools available to us cannot be used unless the data are "scaled," meaning that data are on an interval or a ratio scale of measurement. Indeed, many statistical tools introduced in the next few chapters—and those introduced in Chapters 9–14, 16, and two statistics in Chapter 15—all require "scaled" data to be used. Thus, if rating scales are treated as ordinal measures (the fundamentalists), then we must leave many statistical tools out of our toolbox. On the other hand, if rating scales are treated as "scaled" or interval measures (the pragmatists), then our toolbox will be much fuller—and the most informative decisions can often be made using statistics for scaled data.

In truth, the debate between fundamentalists and pragmatists is quite complex and certainly cannot be resolved here. Both sides make valid arguments; both sides have flaws (Knapp, 1990). Strictly following the rules for scales of measurement, fundamentalists are likely correct—rating scales are ordinal measures (Jamieson, 2004; Kuzon et al., 1996). However, taking into account how rating scale data are actually distributed, and thus, how it can be treated, shows that very often the treatment of rating scale data as interval measures is appropriate in applied research settings (Landry, 2015; Thomas, 1982; Wu & Leung, 2017). That said, because most behavioral scientists tend to be pragmatists (i.e., they tend to treat rating scales as interval measures in the published literature), rating scales are taught here as an interval scale of measurement. However, after reading this book in full, please feel free to review this debate in greater detail to decide for yourself (for insightful discussions, refer to Doering & Hubbard, 1979; Knapp, 1990).

LEARNING CHECK 1.4

1. ______ are rules for how the properties of numbers can change with different uses. [Fill in the blank]
   a. Metrics
   b. Ratios
   c. Estimates
   d. Scales of measurement
2. In 2010, *Fortune* magazine ranked Apple as the most admired company in the world. This ranking is on a(n) ______ scale of measurement. [Fill in the blank]
   a. nominal
   b. ordinal
   c. interval
   d. ratio
3. What are two characteristics of rating scales that allow researchers to use these values on an interval scale of measurement?
   a. Values on a rating scale have a true zero but are not equidistant.
   b. Values on a rating scale are proportional and have a true zero.
   c. Values on a rating scale are equidistant and have a true zero.
   d. Values on a rating scale are assumed to be equidistant and do not have a true zero.
4. A researcher measures the following four variables. Which variable is measured on a ratio scale of measurement?
   a. gender
   b. temperature (in degrees Fahrenheit)
   c. height (in inches)
   d. movie ratings (from 1 to 4 stars)

Answers: 1. d; 2. b; 3. d; 4. c.

1.5 TYPES OF VARIABLES FOR WHICH DATA ARE MEASURED

LO 1.5	Distinguish between variables that are qualitative or quantitative and discrete or continuous.

Scales of measurement reflect the informativeness of data. With nominal scales, researchers can conclude little; with ratio scales, researchers can conclude just about anything in terms of order, difference, and ratios. Researchers also distinguish between the types of data they measure. The variables for which researchers measure data fall into two categories:

- Continuous or discrete
- Quantitative or qualitative

Each category is discussed in this section. Many examples are given to help you delineate these categories in Table 1.3.

Continuous and Discrete Variables

Variables can be categorized as continuous or discrete. A **continuous variable** is measured along a continuum at any place beyond the decimal point. So continuous variables can thus be measured in fractional units. Consider, for example, that Olympic sprinters are timed to the nearest hundredths place (in seconds), but if the Olympic judges wanted to clock them to the nearest millionths place, they could.

A **discrete variable**, on the other hand, is measured in whole units or categories that are not distributed along a continuum. For example, if we count the number of students in your class, a fractional answer does not make sense; instead, we count in whole units. The number of brothers and sisters you have and your family's socioeconomic class (lower class, middle class, upper class) are other examples of discrete variables. Refer to Table 1.3 for more examples of continuous and discrete variables.

Quantitative and Qualitative Variables

Variables can be categorized as quantitative or qualitative. A **quantitative variable** varies by amount or *quantity*—the base for the term *quantit*ative. It is measured numerically and is often collected by measuring or counting. Thus, continuous and discrete variables can be quantitative. For example, we can measure food intake in calories (a continuous variable), or we can count the number of pieces of food consumed (a discrete variable). In both cases, the variable, food intake, is measured by amount (in numeric units).

A **qualitative variable**, on the other hand, varies by class. It is often represented with a label that describes nonnumeric aspects of phenomena—so only discrete variables can be qualitative. For example, class year (freshman, sophomore, junior, senior) is discrete and qualitative; so are many behavioral disorders such as types of anxiety disorders (social anxiety and generalized anxiety) and depression (seasonal affective, postpartum, and major depression). Refer to Table 1.3 for more examples of quantitative and qualitative variables.

To practice identifying the types of data that researchers measure, let us evaluate a few more variables in Example 1.3.

TABLE 1.3 ■ A List of 20 Variables Showing How They Fit Into the Three Categories That Describe Them

Variables	Continuous vs. Discrete	Qualitative vs. Quantitative	Scale of Measurement
Type of book (soft cover, hard cover)	Discrete	Qualitative	Nominal
Season of birth (spring, summer, fall, winter)	Discrete	Qualitative	Nominal
Time (in minutes) to complete a task	Continuous	Quantitative	Ratio
Number of errors in an exam	Discrete	Quantitative	Ratio
Duration of drug abuse (in years)	Continuous	Quantitative	Ratio
Place finishing a race (from 1st to last place)	Discrete	Quantitative	Ordinal
Ratings of satisfaction (1 to 7)	Discrete	Quantitative	Interval
Body type (healthy, overweight, obese)	Discrete	Qualitative	Ordinal
Score (from 0% to 100%) on an exam	Continuous	Quantitative	Ratio
Number of tweets sent during class	Discrete	Quantitative	Ratio
Temperature (degrees Fahrenheit)	Continuous	Quantitative	Interval
Time (in seconds) to memorize a list	Continuous	Quantitative	Ratio
The size of a reward (in grams)	Continuous	Quantitative	Ratio
Number of participants in a sample	Discrete	Quantitative	Ratio
Type of exercise (aerobic, anaerobic)	Discrete	Qualitative	Nominal
Type of distraction (auditory, visual)	Discrete	Qualitative	Nominal
Letter grade in a college class (A, B, C, D, F)	Discrete	Qualitative	Ordinal
Weight of an infant (in pounds)	Continuous	Quantitative	Ratio
A college student's SAT score	Discrete	Quantitative	Interval
Number of lever presses per minute	Discrete	Quantitative	Ratio

EXAMPLE 1.3

For each of the following examples, (1) name the variable being measured, (2) state whether the variable is continuous or discrete, and (3) state whether the variable is quantitative or qualitative.

a. A researcher records the month of birth among patients with schizophrenia.
The month of birth (the variable) is discrete and qualitative.

b. A professor records the number of students absent during a final exam.
The number of absent students (the variable) is discrete and quantitative.

c. A researcher asks children to choose which type of cereal they prefer (one with a toy inside or one without) and records the choice of cereal for each child.
The choice of cereal (the variable) is discrete and qualitative.

d. A therapist measures the time (in hours) that clients continue a recommended program of counseling.
The time in hours (the variable) is continuous and quantitative.

DATA IN RESEARCH

EVALUATING DATA AND SCALES OF MEASUREMENT

Although qualitative variables are often measured in behavioral research, this book will focus largely on quantitative variables. The reason is twofold: (1) Quantitative measures are more common in behavioral research, and (2) most statistical tests taught in this book are adapted for quantitative measures. Indeed, many researchers who measure qualitative variables will also measure those that are quantitative in the same study.

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For example, Flayelle et al. (2017) explored the nature of binge-watching behaviors using a qualitative method. The researchers interviewed each participant in a focus group of seven regular TV series viewers. In the interview, participants could respond openly to questions asked. These researchers then summarized responses into categories related to participant motives for watching, their viewing patterns, self-control, and more. For example, the following participant response was categorized as an example of a social motive for watching TV: "We sometimes text each other while we watch the same show at the same time" (Flayelle et al., 2017, p. 462).

The limitation of this analysis is that categories are on a nominal scale (the least informative scale). So many researchers who record qualitative data also use some quantitative measures. For example, researchers in this study also asked participants to answer a variety of quantitative questions, such as the number of episodes they view during a typical "bingeing" session, how frequently they watch a TV series, and how long they watch a TV series—both during a working day and during a day off. These responses are on a ratio scale, which adds valuable information regarding participant viewing behaviors.

Inevitably, the conclusions we can draw with qualitative data can be rather limited because these data are typically on a nominal scale. However, most statistics introduced in this book require that variables be measured on the more informative scales. For this reason, this book mainly describes statistical procedures for quantitative variables measured on an ordinal, interval, or ratio scale of measurement.

LEARNING CHECK 1.5

1. A ratio scale variable can be continuous or discrete.
   a. True
   b. False

2. A researcher is interested in the effects of stuttering on social behavior with children, and they record the number of peers a child speaks to during a typical school day. In this example, the data are ______. [Fill in the blank]
   a. qualitative
   b. quantitative

For questions 3–6, state whether the variable is continuous or discrete. Answer C for continuous or D for discrete.

3. Delay (in seconds) it takes drivers to make a left-hand turn when a light turns green
4. Number of questions that participants ask during a research study
5. Type of drug use (none, infrequent, moderate, or frequent)
6. Season of birth (spring, summer, fall, or winter)

Answers: 1. a; 2. b; 3. C. 4. D. 5. D. 6. D.

1.6 SPSS IN FOCUS: ENTERING AND DEFINING VARIABLES

SPSS LO 1.6 Enter data into SPSS by placing each group in separate columns and each group in a single column (coding is required).

Throughout this book, we present instructions for using the statistical software program SPSS by showing you how this software can make all the work you do by hand as simple as point and click. Before you read this SPSS section, please take the time to read the section titled "How to Use SPSS With This Book" at the beginning of this book. That section provides an overview of the different views and features in SPSS. This software is an innovative statistical computer program that can compute any statistic taught in this book.

In this chapter, we discussed how variables are defined, coded, and measured. Keep in mind that the Variable View display is used to define the variables you measure, and the Data View display is used to enter the scores you measured. When entering data, make sure that all values or scores are entered in each cell of the Data View spreadsheet. The biggest challenge is making sure you enter the data correctly. Entering even a single value incorrectly can alter the data analyses that SPSS computes. For this reason, always double-check the data to make sure the correct values have been entered.

We can use a simple example. Suppose you record the average GPA of students in one of three statistics classes. You record the GPA scores for each class given in Table 1.4. For this example, the grouping variable is *classes*, and there are three levels: *Class 1, Class 2*, and *Class 3*.

TABLE 1.4 ■ GPA Scores in Three Statistics Classes

Class 1	Class 2	Class 3
3.3	3.9	2.7
2.9	4.0	2.3
3.5	2.4	2.2
3.6	3.1	3.0
3.1	3.0	2.8

There are two ways you can enter these data: by column or by row. We enter data by column when the same participants are observed in each group. For this example, then, let's assume that the same five students are observed in each of the three classes. To *enter data by column*:

1. Open the Variable View tab, shown in Figure 1.7. In the Name column, enter the levels of the grouping variable in each row. The names are *class1, class*2, and *class3* (note that spaces are not allowed). Three rows should be active.

FIGURE 1.7 ■ SPSS Variable View for Entering Data by Column

	Name	Type	Width	Decimals	Label	Values	Missing	Columns	Align	Measure	Role
1	class1	Numeric	8	1		None	None	8	Right	Scale	Input
2	class2	Numeric	8	1		None	None	8	Right	Scale	Input
3	class3	Numeric	8	1		None	None	8	Right	Scale	Input

2. Because the data are to the tenths place, go to the Decimals column and reduce that value to 1 in each row. Because the data are scaled (i.e., GPA is ratio scale data), label each column as Scale in the Measure column.

3. Open the Data View tab. Notice that the first three columns are now labeled with the group names, as shown in Figure 1.8. Enter the data, given in Table 1.4, for each class in the appropriate column. The data for each group (or for each level of the grouping variable *classes*) are now listed down each column.

FIGURE 1.8 ■ Data Entry in SPSS Data View for Entering Data by Column

class1	class2	class3
3.3	3.9	2.7
2.9	4.0	2.3
3.5	2.4	2.2
3.6	3.1	3.0
3.1	3.0	2.8

There is another way to enter these data in SPSS: You can *enter data by row*. This requires *coding* the data. We enter data by row when different participants are observed in each group. For this example, then, let's now assume that different students are observed in the three classes; thus five students in *Class 1*, five students in *Class 2*, and five students in *Class 3*, for a total of 15 students across all classes. To begin, open a new SPSS data file and follow the instructions given here:

1. Open the Variable View tab, shown in Figure 1.9 with the coding (we will code in Step 3) already completed. Enter the grouping variable, *classes*, in the first row in the Name column. Enter *GPA* in the second row in the Name column.

FIGURE 1.9 ■ SPSS Variable View for Entering Data by Row

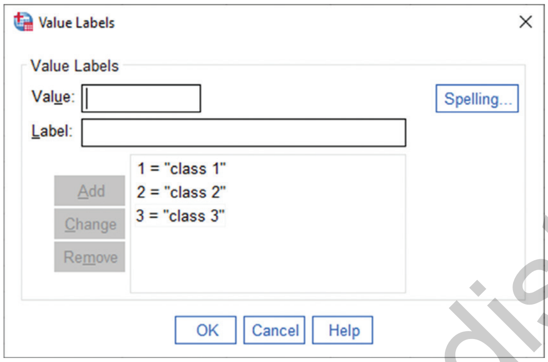
	Name	Type	Width	Decimals	Label	Values	Missing	Columns	Align	Measure	Role
1	classes	Numeric	8	0		{1, class 1}...	None	8	Right	Nominal	Input
2	GPA	Numeric	8	1		None	None	8	Right	Scale	Input

2. Go to the Decimals column and reduce the value to 0 for the first row. You will learn why we did this in the next step. Reduce the Decimals column value to 1 in the second row because we will enter GPA scores for this variable.

3. Go to the Values column for row 1 and click on the small gray box with three dots. In the dialog box shown in Figure 1.10, we will code the levels of the grouping variable. Enter *1* in the Value cell and *class 1* in the Label cell, and then select Add. Repeat these steps by entering *2* for *class 2* and *3* for *class 3*; then select OK. Note that we used whole numbers to code each group, which is why we chose 0 in the Decimals column for the first row in Step 2. When you go back to the Data View tab, SPSS will now recognize

1 as *class 1*, *2* as *class 2*, and so on in the row you labeled *classes* (illustrated in Figure 1.9 with the coding completed for the *classes* variable). Because the data are categories in the first row, label this variable as *Nominal* in the Measure column; label the second row *Scaled* (i.e., GPA is ratio scale data) in the Measure column.

FIGURE 1.10 ■ SPSS Dialog Box for Coding the Variable



4. Open the Data View tab. In the first column, enter *1* five times, *2* five times, and *3* five times. This tells SPSS that there are five students in each class. In the second column, enter the corresponding GPA scores for each class by row. This data entry is shown in Figure 1.11. The data are now entered by row.

FIGURE 1.11 ■

classes	GPA
1	3.3
1	2.9
1	3.5
1	3.6
1	3.1
2	3.9
2	4.0
2	2.4
2	3.1
2	3.0
3	2.7
3	2.3
3	2.2
3	3.0
3	2.8

SPSS Data View for Entering Data by Row

The data for all the variables are labeled, coded, and entered. If you do this correctly, SPSS will make summarizing, computing, and analyzing any statistic taught in this book fast and simple.

LEARNING CHECK 1.6

1. In SPSS, entering data by row requires that the levels of the grouping variable are coded.
   a. True
   b. False

2. Which the following requires coding the levels of the grouping variable?
   a. The same participants are observed at each level of the grouping variable.
   b. Different participants are observed at each level of the grouping variable.
3. A researcher conducts a study in which participants are given an 8-week fitness training. To evaluate whether it was effective, the same participants are given a fitness test in a baseline period prior to the training, then again 4 weeks into the training, and finally at 8 weeks when the training is complete. For this study, will the grouping variable (time of fitness test: baseline, 4 weeks, 8 weeks) need to be coded in SPSS?
   a. No, coding is never required in SPSS.
   b. Yes, because the same participants are observed at each time.
   c. No, because the same participants are observed at each time.

Answers: 1. a; 2. b. 3. c.

CHAPTER SUMMARY

LO 1.1 **Define statistics and explain why it is important to understand.**

- Statistics is a branch of mathematics used to summarize, analyze, and interpret a group of numbers or observations.
- Statistics are important because they are part of our everyday life and they are subject to interpretation. Therefore, understanding statistics is important in that it allows us to be critical consumers of the information we come across every day.

LO 1.2 **Distinguish between descriptive and inferential statistics, samples and populations, and sample statistics and population parameters.**

- Descriptive statistics are procedures used to summarize, organize, and make sense of a set of scores called *data*—typically presented graphically, in tabular form (in tables), or as summary statistics (single values). Inferential statistics are procedures that allow researchers to infer whether observations made with samples are also likely to be observed in the population.
- A population is a set of all individuals, items, or data of interest. A characteristic that describes a population is called a population parameter. A sample is a set of individuals, items, or data selected from a population of interest. A characteristic that describes a sample is called a sample statistic.

LO 1.3 **Describe three research methods commonly applied in the behavioral sciences.**

- The experimental design uses manipulation, randomization, and comparison/control to ensure enough control to allow researchers to draw cause-and-effect conclusions.
- The quasi-experimental design is structured similar to an experiment but lacks randomization and/or a comparison/control group.
- The correlational method is used to measure pairs of scores for each individual and examine the relationship between the variables.

LO 1.4 **State the four scales of measurement and identify examples of each.**

- Scales of measurement identify how the properties of numbers can change with different uses. Scales are characterized by three properties: order, difference, and ratio. There are four scales of measurement: nominal, ordinal, interval, and ratio. Nominal scales are typically coded (e.g., seasons, months, sex), ordinal scales indicate order alone (e.g., rankings, grade level), interval scales have values that are (or are assumed to be) equidistant and no true zero (e.g., rating scale values, temperature), and ratio scales are also distributed in equal units but have a true zero (e.g., weight, height, calories).

LO 1.5 **Distinguish between variables that are qualitative or quantitative and discrete or continuous.**

- A continuous variable is measured along a continuum, whereas a discrete variable is measured in whole units or categories. Hence, continuous but not discrete variables are measured at any place beyond the decimal point. A quantitative variable varies by amount, whereas a qualitative variable varies by class.

SPSS LO 1.6 **Enter data into SPSS by placing each group in separate columns and each group in a single column (coding is required).**

- SPSS can be used to enter and define variables. All variables are defined in the Variable View tab. The values recorded for each variable are listed in the Data View tab. In the Data View tab, data can be entered by column (when the same participants are observed in each group or at each level of the grouping variable). In the Data View tab, data can also be entered by row (when different participants are observed in each group or at each level of the grouping variable). Listing data by row requires coding the variable. Variables are coded in the Variable View tab in the Values column (for more details, refer to Section 1.6).

KEY TERMS

coding
continuous variable
correlational method
data
datum
dependent variable (DV)
descriptive statistics
discrete variable
equidistant scale
experiment
factor
independent variable (IV)
inferential statistics
interval scale
levels of the factor
levels of the independent variable
nominal scale
operational definition
ordinal scale
population
population parameter
qualitative variable
quantitative variable
quasi-experimental method
quasi-independent variable
random assignment
ratio scale
raw score
research method
sample
sample statistic
scales of measurement
science
scientific method
score
statistics
true zero

END-OF-CHAPTER PROBLEMS

1. Statistics is a branch of mathematics used to

a. make inferences about populations based on observations made in samples.
b. summarize, analyze, and interpret a group of numbers or observations.
c. summarize data measured in samples but not data measured in populations.

2. Which of the following explains how statistics can be used?
   a. Statistics can be used to understand and interpret data.
   b. Statistics can be used to summarize data to make sense of it.
   c. Both *a* and *b* are correct.

3. A researcher records the value of home prices over a period of years from before to following a recession. Which of the following is the statistic measured in this example?
   a. years
   b. home prices
   c. whether or not there was a recession

4. A professor records the number of questions that students ask during class in each class during a semester. Which of the following is the statistic measured in this example?
   a. the class in which students asked questions
   b. the semester in which observations were made
   c. the number of questions that students ask during class

5. Understanding statistics is important in that it allows you
   a. to be a critical consumer of the information you come across
   b. to be a critical consumer of scientific information
   c. Both a and b are correct.

6. Which of the following best explains what it means to "be a critical consumer" of statistical information?
   a. It means that you can critically evaluate statistical information to distinguish between appropriate and misleading statistics.
   b. It means that you can be critical of all statistics so that no statistical reporting is accepted as appropriate.
   c. It means that to be able to understand statistics, you need to be critical of consumers in the marketplace.

For Questions 7 and 8, state whether the word listed best identifies descriptive statistics or inferential statistics. Answer D for descriptive statistics and I for inferential statistics.

7. summarize

8. generalize

For Questions 9 and 10, identify whether the statement is true or false. Answer T for true and F for false.

9. Graphs, tables, and summary statistics all illustrate the application of inferential statistics.

10. Descriptive statistics can be used to describe populations and samples of data.

11. A researcher is interested in sampling students to participate in a study on learning and memory. Which of the following describes the procedures the researcher would use to select a sample?
   a. The researcher identifies the population of students, then selects a portion of them to participate in the study.
   b. The researcher identifies the population of students, then selects all of them to participate in the study.

12. A statistics class has 25 students enrolled, but only 23 students attended class. In this class, which value represents the population of students enrolled?
   a. 23
   b. 25

13. Researchers measure ____ in a sample to learn more about ____ in the larger population of interest. [Fill in the blanks]
- **a.** statistics; parameters
- **b.** parameters; statistics

14. A psychologist reviews notes for all of their patients and determines that on average, patients complete therapy in 24 days. The average time to complete therapy among all their patients is called a
- **a.** sample statistic
- **b.** population parameter

15. A researcher tests the effectiveness of a new drug treatment by randomly assigning participants to a group that receives the drug treatment or to a control group where a placebo (i.e., fake) drug is administered. What type of research method is described in this example?
- **a.** experimental
- **b.** quasi-experimental
- **c.** correlational

16. Which of the following is an example of a study that is structured like an experiment?
- **a.** A study evaluating the extent to which exercise frequency and self-image are related among college students.
- **b.** A study evaluating whether the amount consumed in a buffet differs between participants who are overweight or obese.
- **c.** A study evaluating whether scores on an academic assessment differ between children randomly assigned to one of two learning groups.

For Questions 17 and 18, identify whether the variable described is an independent variable or a dependent variable for an experiment. Answer I for an independent variable and D for a dependent variable.

17. The variable measured in each group.

18. The variable that is manipulated to create the groups.

19. A researcher records differences in attention between students who drink coffee and those who do not drink coffee. What type of research method is described in this example?
- **a.** experimental
- **b.** quasi-experimental
- **c.** correlational

20. Suppose a researcher records differences in cell phone use during class between students who are in lower-level classes and advanced classes. What is the quasi-independent variable in this example?
- **a.** cell phone use
- **b.** class level (lower-level, advanced)
- **c.** the college where students were observed

For Questions 21 and 22, identify whether the statement regarding a correlational method is true or false. Answer T for true and F for false.

21. A correlation identifies whether changes in one variable cause changes in a second variable.

22. The correlational method does not control the conditions under which observations are made.

23. In the published literature, rating scales—which are widely used in the behavioral sciences—are typically treated as ____ scale measures. [Fill in the blank]
- **a.** nominal
- **b.** ordinal
- **c.** interval
- **d.** ratio

24. The procedure of converting a categorical variable to numeric values is called:
- **a.** coding
- **b.** piloting
- **c.** constructing

For Questions 25–28, identify the scale of measurement for the variable described. Answer N for nominal, O for ordinal, I for interval, and R for ratio.

25. the time (in minutes) to finish an exam

26. place finishing a race (from 1st to last place)

27. season of birth (winter, spring, summer, fall)

28. temperature (in degrees Fahrenheit)

29. The data for which type of variables are often subjected to statistical analysis?
- **a.** quantitative
- **b.** qualitative

30. Recording which friend students study with describes ____ types of data, whereas recording the number of hours spent studying per week describes ____ types of data. [Fill in the blanks]
- **a.** qualitative; quantitative
- **b.** quantitative; qualitative
- **c.** qualitative; discrete
- **d.** quantitative; continuous

For Questions 31 and 32, identify whether the statement describes a continuous or discrete variable. Answer C for continuous and D for discrete.

31. This variable can be either qualitative or quantitative.

32. This variable can only be quantitative, not qualitative.

33. Which of the following statements is true for entering data into SPSS?
- **a.** When different participants are observed in each group, we code the grouping variable.
- **b.** When entering data into SPSS, we enter data by column when the same participants are observed in each group.
- **c.** Both a and b are correct.

34. A researcher observes patrons at a sporting event and compares differences in social interactions between the "home team" and the "away team" fans. Assuming that a patron could not be both a home team and an away team fan, which of the following is true for entering these data into SPSS?
- **a.** The home team data will be entered in one column and the away team data will be entered in a second column in the data view tab.
- **b.** The grouping variable (type of fan) will be coded in the variable view tab.
- **c.** Both a and b are correct.

Answers for even-numbered questions are in Appendix E.

- The following end-of-chapter problems are designated as problems to test the SPSS learning objective: 33 and 34.

Visit **edge.sagepub.com/priviterastats4e** to access resources including datasets and SPSS screencasts.