may also want to consider the following questions as you are presented with findings from research studies both in and outside of this text.

- How do we meaningfully evaluate the validity of any claim?
- As we assess research, what evidence is meaningful, and why?
- To what degree can one truly control experimental conditions so as to reasonably ascertain cause and effect?
- Have the research findings been replicated?
- Are the conclusions credible based on the information presented?
- What other questions do you have that have not been answered by the information presented?

Experimentation in Psychology

We begin with a discussion of **experimentation** in psychology. Many people refer to research in general as "experimentation," but an experiment is a specific type of research in which participants are randomly assigned to groups and researchers manipulate a variable known as the independent variable. Other types of research that we discuss in this chapter are *correlational studies, case studies, interviews, surveys, naturalistic observation, cross-sectional studies,* and *longitudinal studies*. By the end of this chapter, you should have an understanding of how each of these types of research is conducted, which research questions lend themselves to each research method, and a sense of each method's strengths and limitations.

Variables

The basic goal in an experiment is to determine if some variable that the researchers manipulate (the **independent variable** or **IV**) has a cause and effect relationship with some outcome that is measured (the **dependent variable** or **DV**). When trying to identify these components of an experiment, it may be useful to reframe the experimental setup each time using an "if" and "then" statement. The independent variable is the "if" part of the statement and is *the component that is manipulated by the researchers*. If you are stuck, ask yourself how the participants are being treated differently between the different conditions; the answer is likely to be the independent variable. The dependent variable is the outcome, or *what is being measured in a study*. If a teacher wants to determine if distributed practice (study for 20 minutes each night for a 2-week period) is more effective than cramming (studying the same amount of time, but all at once) in preparation for an exam, she may randomly assign a group of students to use distributed practice, and another group to use cramming. As one of these techniques may be more effective than others, the researcher should run this as a laboratory experiment rather than an experiment in actual classes because the results may impact the student's grades.

Hypotheses

At the start of experimental research, the researcher formulates an **alternative** (or research) **hypothesis**, which is a prediction of the effect the independent variable will have on the dependent variable. A scientific hypothesis must be falsifiable – that is, the research findings can demonstrate that the alternative hypothesis is correct or not correct. An assertion that is not falsifiable is really a matter of opinion, and these types of statements fall out of the guidelines of the scientific method. Good researchers will not make a claim without evidence to support that claim. The best studies in psychology have stood up to repeated attempts to falsify them. However, rather than trying to "prove" their alternative hypothesis is correct, psychological scientists look for evidence that may lead them to reject the **null hypothesis**, which is the statement that the independent variable has no effect on the dependent variable. We assume the null hypothesis is correct until we encounter scientific evidence to reject it. Researchers know that they can reject the null hypothesis and accept the alternative hypothesis once they run a statistical analysis of their data (the specific statistical test is determined by the type of data collected and you will not be expected to know how to compute the statistical tests for the AP exam). The analysis will result in a **p-value** that will indicate *how likely it is that the null hypothesis is true* (*i.e., that the result is due to chance*). We discuss this later in the chapter in the section on statistics.

It is necessary for experimenters to establish **operational definitions** (a definition of a concept or phenomenon based on how it is measured in the study) of the concepts under study. It is impossible to reliably assess something that is poorly defined. Having clear and precise operational definitions allows for **replication**. Replication occurs when other researchers repeat a study to see if the results confirm or find support for the conclusion of the original study. Many concepts in psychology are difficult to define and may be interpreted differently by different researchers. For this reason, clear operational definitions are essential for psychological research. In the earlier example in which teaching methods (IV) were evaluated in terms of how well students performed on an exam (DV), the scores on the exam are quantifiable and clear. However, topics in psychology like self-esteem or motivation are more difficult to define. In studying such topics, it is essential to indicate how they are being measured. In this way, future researchers can do replication studies. This approach also requires researchers to be honest and transparent in how they conduct their study and they should be willing to share their data with other researchers.

In order to determine if the result is due to the manipulation of the independent variable, the researcher(s) must attempt to control for possible **confounding variables**. These are variables other than the IV that might account for differences among the groups in the experiment. These variables can confuse and often invalidate research results, so experimenters go to great lengths to try to control for all potential factors that may influence the results of the study. If you were testing the effect of different study techniques (the IV) on exam performance (the DV), you would want to be sure that any difference between the experimental group (the group that receives the manipulation) and the control group

(the group that does not receive the manipulation) was due only to the difference in study technique. You would not want one group to do better than the other because one took the exam when bright and fresh at 9:00 a.m. while the second group took the test at 4:30 p.m. after a full day of classes. You would not want one group to take the exam in an air-conditioned room while the second group slogged through the exam in unpleasantly hot conditions. The differences in time of day and testing environment might account for the differences in performance between the two groups, so you need to control for these possible confounding variables. One important way to eliminate potential confounding variables between participants in different groups is to use random assignment. All research participants should have an equal chance of being placed into the different conditions in the study. This procedure would ensure that all students with high grades or strong exam takers do not wind up in the same group in the research study. Control variable are those that remain constant for both groups and should include all aspects of the study with the exception of the independent variable. While it is never possible to control for all confounding variables in research, the more we can control, the more likely we can say that any differences among the groups are likely due to the manipulation of the independent variable rather than luck or chance.

ALTERNATIVE HYPOTHESIS	NULL HYPOTHESIS	INDEPENDENT VARIABLE (I.V.)	DEPENDENT VARIABLE (D.V.)	CONFOUNDING VARIABLE
A statement of the expected result in a study. That the IV will impact the DV	A statement that indicates that the IV will have no impact on the DV	What the experimenter manipulates in a study	The outcome or what is measured in a study	Variables the experimenter did not control for that may have impacted the results of a study
Example: If people use a flipped classroom method of teaching, then student AP exam performance will improve.	**Example:** The teaching method will have no impact on AP exam performance.	**Example:** Teaching style (traditional lecture versus flipped classroom)	**Example:** AP exam performance	**Example:** The amount of sleep a participant had the night before the exam.