REVIEW AND REFLECT

Correlation

Correlation and Causation

The strength of the relationship between one factor and another is expressed as a number in their *correlation coefficient*. Scatterplots and the correlations they reveal help us to see relationships that the naked eye might miss. Knowing how closely two things are positively or negatively correlated tells us how much one predicts the other. But it is crucial to remember that correlation is a measure of relationship; it does not reveal cause and effect.

Illusory Correlations and Perceiving Order in Random Events

Correlations also help us to discount relationships that do not exist. Illusory correlations—random events we notice and assume are related—arise from our search for patterns.

CHECK YOURSELF: Here are some recently reported correlations, with interpretations drawn by journalists. Further research, often including experiments, has clarified cause and effect in each case. Knowing just these correlations, can you come up with other possible explanations for each of these?

a. Alcohol use is associated with violence. (One interpretation: Drinking triggers or unleashes aggressive behavior.)
b. Educated people live longer, on average, than less-educated people. (One interpretation: Education lengthens life and enhances health.)
c. Teens engaged in team sports are less likely than other teens to use drugs, smoke, have sex, carry weapons, and eat junk food less often than teens who do not engage in team sports. (One interpretation: Team sports encourage healthy living.)
d. Adolescents who frequently see smoking in movies are more likely to smoke. (One interpretation: Movie stars' behavior influences impressionable teens.)

ASK YOURSELF: Can you think of an example of correlational research that you recently heard about from a friend or on the news? Was an unwarranted conclusion drawn?

Answers to the Check Yourself questions can be found in the yellow appendix at the end of the book.

R. Sidney/The Image Works

Correlation need not mean causation
Length of marriage correlates with hair loss in men. Does this mean that marriage causes men to lose their hair (or that balding men make better husbands)? In this case, as in many others, a third factor obviously explains the correlation: Golden anniversaries and baldness both accompany aging.

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Shorewood High School

Experimentation

Preview: To discern cause and effect, psychologists experiment. In the typical experiment they randomly assign some people to experience a treatment of interest, while others have no such experience. Because the random assignment equalizes the groups at the outset, any later differences were probably caused by the experimental variable being tested.

Happy are they "who have been able to perceive the causes of things," remarked the Roman poet Virgil. We endlessly wonder and debate *why* we act as we do. Why do some people smoke? Have babies while they are still children? Do stupid things when drunk? Become troubled teens and open fire on their classmates? Though psychology cannot answer these questions directly, it has helped us to understand what influences drug use, sexual behaviors, thinking when drinking, and aggression.

Many factors influence our everyday behavior. To isolate cause and effect—say, in looking for possible causes of depression—psychologists sometimes try to statistically control for other factors. For example, many studies have found that breast-fed infants grow up with somewhat higher intelligence scores than those of infants bottle-fed with cow's milk (Angelsen & others, 2001; Gale & Martyn, 1996; Johnson & others, 1996; Lucas & others, 1992; Mortensen & others, 2002; Quinn & others, 2001). Mother's milk correlates modestly but positively with later intelligence. But does this mean that smarter mothers (who more often breast-feed) have smarter children? Or, as some researchers believe, do the nutrients of mother's milk contribute to brain development? To help answer this question, researchers have "controlled for" (statistically removed differences in) maternal age, education, and intelligence. Still, breast-fed infants exhibit slightly higher intelligence as young children.

The clearest and cleanest way to isolate cause and effect is, however, to **experiment**. Experiments enable a researcher to focus on the possible effects of one or more factors by (1) *manipulating the factors of interest* and (2) *holding constant ("controlling") other factors*. Knowing that correlations of infant nutrition and later intelligence can't possibly control for all other possible factors, a British research team led by Alan Lucas (1998) decided to experiment, using 424 hospital preterm infants. With parental permission, the researchers randomly assigned some infants to standard infant formula feedings and others to donated breast milk feedings. When given intelligence tests at age 8, the children nourished with breast milk had significantly higher intelligence scores than their formula-fed counterparts. No single experiment is conclusive of course, but these researchers by randomly assigning infants to a feeding condition, were able to hold constant all factors except nutrition. This rigorous design helps eliminate alternative explanations and supports the conclusion that, so far as the developing intelligence of preterm infants is concerned, breast is best.

If behavior changes when we vary an experimental factor, such as infant nutrition, then we know that the factor is having an effect. *The important point to remember:* Unlike correlational studies, which uncover naturally occurring relationships, an experiment manipulates a factor to determine its effect. Let's consider some more experiments.

experiment a research method in which an investigator manipulates one or more factors (independent variables) to observe the effect on some behavior or mental process (the dependent variable). By random assignment of participants, the experiment controls other relevant factors.

double-blind procedure an experimental procedure in which both the research participants and the research staff are ignorant (blind) about whether the research participants have received the treatment or a placebo. Commonly used in drug-evaluation studies.

placebo effect experimental results caused by expectations alone; any effect on behavior caused by the administration of an inert substance or condition, which is assumed to be an active agent.

experimental condition the condition of an experiment that exposes participants to the treatment, that is, to one version of the independent variable.

control condition the condition of an experiment that contrasts with the experimental condition and serves as a comparison for evaluating the effect of the treatment.

random assignment assigning participants to experimental and control conditions by chance, thus minimizing preexisting differences between those assigned to the different groups.

independent variable the experimental factor that is manipulated; the variable whose effect is being studied.

dependent variable the experimental factor—in psychology, the behavior or mental process—that is being measured; the variable that may change in response to manipulations of the independent variable.

Evaluating Therapies

Our tendencies to seek new remedies when we are ill or emotionally down can produce misleading testimonies. When our health or emotions return to normal, we attribute the return to something we have done. If three days into a cold we start taking vitamin C tablets and find our cold symptoms lessening, the pills may seem more potent than they are (an illusion of control). If, after nearly failing the first exam, we listen to a "peak learning" subliminal tape and then improve on the next exam, we may credit the tape rather than conclude that our performance has returned to our average. In the 1700s, blood-letting *seemed* effective. Sometimes people improved after the treatment; when they didn't, the practitioner inferred the disease was too far advanced to be reversed. So, whether or not a remedy is truly effective, enthusiastic users will probably endorse it. To find out whether it actually is effective, we must experiment.

And that is precisely how new drug treatments and new methods of psychological therapy are evaluated (Chapter 16). In many of these studies, the participants are *blind* (uninformed) about what treatment, if any, they are receiving. One group receives the treatment. Others receive a pseudotreatment—an inert *placebo* (perhaps a pill with no drug in it). Often neither the participant nor the researc

assistant collecting the data knows whether the participant's group is receiving the treatment. This **double-blind procedure** enables researchers to check a treatment's actual effects apart from the research participants' (and their own) enthusiasm for it and from the healing power of belief. The **placebo effect** is well documented with pain, depression, and anxiety (Kirsch & Sapirstein, 1998). Just *thinking* one is getting a treatment can boost one's spirits, relax one's body, and lead to symptom relief.

The double-blind procedure creates an **experimental condition** in which people receive the treatment and a contrasting **control condition** without the treatment. By **randomly assigning** people to these conditions the two groups should otherwise be identical. Random assignment roughly equalizes the two groups in age, attitudes, and every other characteristic. With random assignment, as occurred with the infants in the breast milk experiment, we can know that any later differences between people in the experimental and control conditions must be the result of the treatment.

Another example: On the advice of their physicians, millions of postmenopausal women turned to hormone replacement therapy after correlational studies found that women on replacement hormones had lower rates of heart disease, stroke, and colon cancer. But women who got the therapy were perhaps more likely to be receiving medical care, exercising, and eating well. So, did the hormones make women healthy or did healthy women take the hormones? In 2002, the National Institutes of Health announced the surprising results of a massive experiment that randomly assigned 16,608 healthy women to either replacement hormones or a placebo: Compared to women in the control condition, women receiving the hormones had *more* health problems (Love, 2002).

And an even more potent example: The drug Viagra was approved for use after 21 clinical trials, including an experiment in which researchers randomly assigned 329 men with impotence to either an experimental condition (Viagra) or a control condition (a placebo). It was a double-blind procedure—neither the men nor the person who gave them the pills knew which drug they were receiving. The result: At peak doses, 69 percent of Viagra-assisted attempts at intercourse were successful, compared with 22 percent for men receiving the placebo (Goldstein & others, 1998). Viagra worked.

This simple experiment manipulated just one drug factor. We call this experimental factor the **independent variable** because we can vary it independently of other factors, such as the men's age, weight, and personality (which random assignment controls). Experiments examine the effect of one or more independent variables on some measurable behavior, called the **dependent variable** because it can vary *depending* on what takes place during the experiment. Both variables are given precise operational definitions, which specify the procedures that manipulate the independent variable (the precise drug dosage and timing in this study) or measure the dependent variable (the questions that assessed the men's responses). These definitions answer the "What do you mean?" question with a level of precision that enables others to repeat the study.

Let's recap. A variable is anything (infant nutrition, intelligence, hair color—whatever) that can vary. Experiments aim to *manipulate* an *independent* variable, *measure* the *dependent* variable, and *control* all other variables. An experiment has at least two different conditions: a comparison or control condition and an experimental condition. Random assignment equates the conditions before any treatment effects. In this way, an experiment tests the effect of at least one independent variable (the

Answer to question in Figure 1.9 (page 36): Player B, whose outcomes may look more random, actually has fewer streaks than would be expected by chance. For these players, chance shooting, like chance coin tossing, should produce a change in outcome about 50 percent of the time. But 70 percent of the time (14 times out of 20), Player B's outcome changes on successive shots. Player A is scoring more, as we would expect from a 50 percent shooter; 10 times out of 20, Player A's next outcome differs from the last.

Note the distinction between random *sampling* in surveys and random *assignment* in experiments. Random sampling helps us generalize to a larger population. Random assignment controls extraneous influences, which helps us infer cause and effect.

TABLE 1.2

COMPARING RESEARCH METHODS

Research Method	Basic Purpose	How Conducted	What Is Manipulated	Possible Problems
Descriptive	To observe and record behavior	Do case studies, surveys, or naturalistic observations	Nothing	Atypical sample; biased observations
Correlational	To detect naturally occurring relationships; to assess how well one variable predicts another	Compute statistical association, sometimes among survey responses	Nothing	Does not specify cause and effect
Experimental	To explore cause and effect	Manipulate one or more factors; use random assignment	The independent variable(s)	Sometimes not feasible; results may not generalize to other contexts

experimental factor) on at least one dependent variable (the measured response). Table 1.2 compares the features of psychology's research methods.

These concepts—experimental and control conditions, independent and dependent variables, random assignment—are important, yet easily confused. So let's put them to work with another intriguing set of experiments.

Can Subliminal Tapes Improve Your Life?

A new generation of entrepreneurs would have you believe so. We are bombarded by mail-order catalogs, cable television ads, and bookstores offering tapes whose imperceptibly faint messages supposedly "reprogram your unconscious mind for success and happiness." While struggling students listen to soothing music, subliminal messages (those below one's hearing threshold) are said to persuade the unconscious that "I am a good student. I love learning." Procrastinators can be similarly reprogrammed: "I set my priorities. I get things done ahead of time!"

Is there anything to these claims? Could positive subliminal messages help us, even a little? Chapter 5 will show that subliminal sensation is for real. We, in fact, do process much information without conscious awareness. And under certain conditions, a stimulus too weak to recognize can affect us, *briefly*.

But does this subtle, fleeting effect extend to the powerful, enduring influence claimed by the subliminal tape merchants? Anthony Greenwald and his colleagues (1991) wanted to find out, so they randomly assigned university students to listen daily for five weeks to commercial subliminal tapes claiming to improve either self-esteem or memory. But the researchers had manipulated an experimental factor. On half the tapes they switched the labels. Some students *thought* they were receiving affirmations of self-esteem when they actually were hearing the memory enhancement tape. Others got the self-esteem tape but *thought* their memory was being recharged (**FIGURE 1.10**).

In this experiment, what was the independent variable? The dependent variable? (See page 42.)

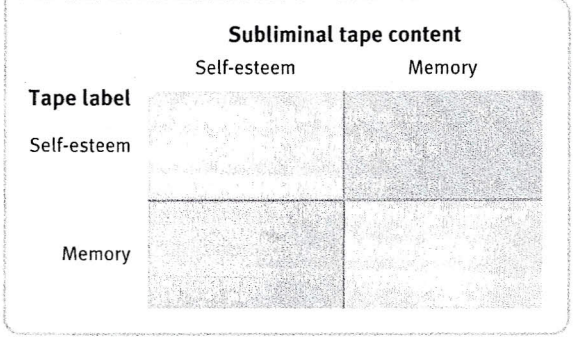

FIGURE 1.10
Design of the subliminal tapes experiment
Students' self-esteem and memory abilities were assessed before and after listening to subliminal tapes purporting to increase either self-esteem or memory. Half the students, however, received deliberately mislabeled tapes.

Were the tapes effective? Their scores on tests for both self-esteem and memory, taken before and after the five weeks, revealed zilch. No ef-

fects. None. And yet, those who *thought* they had heard a memory tape *believed* their memories had improved. A similar result occurred for those who thought they had heard a self-esteem tape. The tapes had no effects, yet the students *perceived* themselves receiving the benefits they *expected*. When reading this research, you can hear echoes of the testimonies that ooze from the mail-order tape catalogs. Many customers, having bought what is not supposed to be heard, and having indeed not heard it, actually write things like, "I really know that your tapes were invaluable in reprogramming my mind." Greenwald conducted 16 double-blind experiments evaluating subliminal self-help tapes over one 10-year period. His results were uniform: Not one had any therapeutic effect (Greenwald, 1992).

Unfortunately, the general public is surprisingly uninformed about the importance of controlled experiments such as this. One science literacy survey asked people to imagine testing a new drug to combat high blood pressure (Miller & Pifer, 1996). The survey asked whether it would make more sense to give the drug to 1000 individuals and see what happened, or to give it to half of them and compare their reactions to those who got no drug. One-third said it would make more sense to give the drug to all 1000 people, reasoning that the greater the number tested, the more reliable the finding. Among those who selected the option with the control group, 30 percent did so simply to save lives, saying "If the drug kills people, it kills only half as many." Again, remember: Psychology's most powerful tool for sorting reality from wishful thinking and for evaluating cause and effect is the control group.

Experiments can also help us evaluate social programs. Do early childhood education programs boost impoverished children's chances for success? What are the effects of different anti-smoking campaigns? Does school sex education reduce teen pregnancies? To answer these questions, we can use experiments: If an intervention is welcomed but resources are scarce, we could use a lottery to randomly assign some people (or regions) to experience the new program and others to a control condition. If later the two groups differ, there will be less to argue about (Passell, 1993).

REVIEW AND REFLECT

Experimentation

To discover cause-and-effect relationships, psychologists conduct *experiments*. By constructing a controlled reality, experimenters can manipulate one or more factors and discover how these independent variables affect a particular behavior, the dependent variable.

Evaluating Therapies, and Can Subliminal Tapes Improve Your Life?

In many experiments, control is achieved by randomly assigning people either to the experimental condition, the group exposed to the treatment, or to a control condition, a group that experiences no treatment or a different version of the treatment.

CHECK YOURSELF: Why, when testing a new drug for blood pressure, would we learn more about its effectiveness from giving it to half of the participants in a group of 1000 than to all 1000 participants?

ASK YOURSELF: If you were to become a research psychologist, what questions would you like to explore with experiments?

Answers to the Check Yourself questions can be found in the yellow appendix at the end of the book.

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