

SECTION 4.2**Exercises**

- 45. Chocolate and happy babies** A University of Helsinki (Finland) study wanted to determine if chocolate consumption during pregnancy had an effect on infant temperament at age 6 months. Researchers began by asking 305 healthy pregnant women to report their chocolate consumption. Six months after birth, the researchers asked mothers to rate their infants' temperament, including smiling, laughter, and fear. The babies born to women who had been eating chocolate daily during pregnancy were found to be more active and "positively reactive"—a measure that the investigators said encompasses traits like smiling and laughter.³⁰
- Was this an observational study or an experiment? Justify your answer.
 - What are the explanatory and response variables?
 - Does this study show that eating chocolate regularly during pregnancy helps produce infants with good temperament? Explain.
- 46. Child care and aggression** A study of child care enrolled 1364 infants and followed them through their sixth year in school. Later, the researchers published an article in which they stated that "the more time children spent in child care from birth to age four-and-a-half, the more adults tended to rate them, both at age four-and-a-half and at kindergarten, as less likely to get along with others, as more assertive, as disobedient, and as aggressive."³¹
- Is this an observational study or an experiment? Justify your answer.
 - What are the explanatory and response variables?
 - Does this study show that child care causes children to be more aggressive? Explain.
- 47. Learning biology with computers** An educator wants to compare the effectiveness of computer software for teaching biology with that of a textbook presentation. She gives a biology pretest to each of a group of high school juniors, then randomly divides them into two groups. One group uses the computer, and the other studies the text. At the end of the year, she tests all the students again and compares the increase in biology test scores in the two groups.
- Is this an observational study or an experiment? Justify your answer.
 - If the group using the computer has a much higher average increase in test scores than the group using the textbook, what conclusions, if any, could the educator draw?
- 48. Cell phones and brain cancer** One study of cell phones and the risk of brain cancer looked at a group of 469 people who have brain cancer. The investigators matched each cancer patient with a person of the same age, gender, and race who did not have brain cancer, then asked about the use of cell phones. Result: "Our data suggest that the use of handheld cellular phones is not associated with risk of brain cancer."³²
- Is this an observational study or an experiment? Justify your answer.
 - Based on this study, would you conclude that cell phones do not increase the risk of brain cancer? Why or why not?
- 49. Effects of class size** Do smaller classes in elementary school really benefit students in areas such as scores on standardized tests, staying in school, and going on to college? We might do an observational study that compares students who happened to be in smaller and larger classes in their early school years. Identify a lurking variable that may lead to confounding with the effects of small classes. Explain how confounding might occur.
- 50. Effects of binge drinking** A common definition of "binge drinking" is 5 or more drinks at one sitting for men and 4 or more for women. An observational study finds that students who binge drink have lower average GPA than those who don't. Identify a lurking variable that may be confounded with the effects of binge drinking. Explain how confounding might occur.
- For the experiments described in Exercises 51 to 56, identify the experimental units or subjects, the explanatory variables (factors), the treatments, and the response variables.*
- 51. Growing in the shade** Ability to grow in shade may help pines found in the dry forests of Arizona to resist drought. How well do these pines grow in shade? Investigators planted pine seedlings in a greenhouse in either full light, light reduced to 25% of normal by shade cloth, or light reduced to 5% of normal. At the end of the study, they dried the young trees and weighed them.
- 52. Internet telephone calls** You can use Voice over Internet Protocol (VoIP) to make long-distance telephone calls over the Internet. How will the cost affect the use of this service? A university plans an experiment to find out. It will offer the service to all

350 students in one of its dormitories. Some students will pay a low flat rate. Others will pay higher rates at peak periods and very low rates off-peak. The university is interested in the amount and time of use and in the effect on the congestion of the network.

- 53. Improving response rate** How can we reduce the rate of refusals in telephone surveys? Most people who answer at all listen to the interviewer's introductory remarks and then decide whether to continue. One study made telephone calls to randomly selected households to ask opinions about the next election. In some calls, the interviewer gave her name, in others she identified the university she was representing, and in still others she identified both herself and the university. For each type of call, the interviewer either did or did not offer to send a copy of the final survey results to the person interviewed. Do these differences in the introduction affect whether the interview is completed?
- 54. Eat well and exercise** Most American adolescents don't eat well and don't exercise enough. Can middle schools increase physical activity among their students? Can they persuade students to eat better? Investigators designed a "physical activity intervention" to increase activity in physical education classes and during leisure periods throughout the school day. They also designed a "nutrition intervention" that improved school lunches and offered ideas for healthy home-packed lunches. Each participating school was randomly assigned to one of the interventions, both interventions, or no intervention. The investigators observed physical activity and lunchtime consumption of fat.



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Fabric science A maker of fabric for clothing is setting up a new line to "finish" the raw fabric. The line will use either metal rollers or natural-bristle rollers to raise the surface of the fabric; a dyeing-cycle time of either 30 or 40 minutes; and a temperature of either 150° or 175° Celsius. An experiment will compare all combinations of these choices. Three specimens of fabric will be subjected to each treatment and scored for quality.

- 56. Exercise and heart rate** A student project measured the increase in the heart rates of fellow students when they stepped up and down for three minutes to the beat of a metronome. The step was either 5.75 or 11.5 inches high and the metronome beat was 14, 21, or 28 steps per minute. Five students stepped at each combination of height and speed.

- 57. Cocoa and blood flow** A study conducted by Norman Hollenberg, professor of medicine at Brigham and Women's Hospital and Harvard Medical School, involved 27 healthy people aged 18 to 72. Each

subject consumed a cocoa beverage containing 900 milligrams of flavonols (a class of flavonoids) daily for five days. Using a finger cuff, blood flow was measured on the first and fifth days of the study. After five days, researchers measured what they called "significant improvement" in blood flow and the function of the cells that line the blood vessels.³³ What flaw in the design of this experiment makes it impossible to say whether the cocoa really caused the improved blood flow? Explain.

- 58. Reducing unemployment** Will cash bonuses speed the return to work of unemployed people? A state department of labor notes that last year 68% of people who filed claims for unemployment insurance found a new job within 15 weeks. As an experiment, this year the state offers \$500 to people filing unemployment claims if they find a job within 15 weeks. The percent who do so increases to 77%. What flaw in the design of this experiment makes it impossible to say whether the bonus really caused the increase? Explain.
- 59. Layoffs and "survivor guilt"** Workers who survive a layoff of other employees at their location may suffer from "survivor guilt." A study of survivor guilt and its effects used as subjects 120 students who were offered an opportunity to earn extra course credit by doing proofreading. Each subject worked in the same cubicle as another student, who was an accomplice of the experimenters. At a break midway through the work, one of three things happened:

Treatment 1: The accomplice was told to leave; it was explained that this was because she performed poorly.

Treatment 2: It was explained that unforeseen circumstances meant there was only enough work for one person. By "chance," the accomplice was chosen to be laid off.

Treatment 3: Both students continued to work after the break.

The subjects' work performance after the break was compared with performance before the break.³⁴ Describe how you would randomly assign the subjects to the treatments

- using slips of paper.
- using Table D.
- using technology.

- 60. Effects of TV advertising** Figure 4.3 (page 235) displays the 6 treatments for a two-factor experiment on TV advertising. Suppose we have 150 students who are willing to serve as subjects. Describe how you would randomly assign the subjects to the treatments

- using slips of paper.
- using Table D.
- using technology.

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- 61. Headache relief** Doctors identify “chronic tension-type headaches” as headaches that occur almost daily for at least six months. Can antidepressant medications or stress management training reduce the number and severity of these headaches? Are both together more effective than either alone? Investigators compared four treatments: antidepressant alone, placebo alone, antidepressant plus stress management, and placebo plus stress management. The headache sufferers named in the following table have agreed to participate in the study.

Acosta	Duncan	Han	Liang	Padilla	Valasco
Asihiro	Durr	Howard	Maldonado	Plochman	Vaughn
Bennett	Edwards	Hruska	Marsden	Rosen	Wei
Bikalis	Farouk	Imrani	Montoya	Solomon	Wilder
Chen	Fleming	James	O'Brian	Trujillo	Willis
Clemente	George	Kaplan	Ogle	Tullock	Zhang

- (a) Outline the design of the experiment. What is this type of design called?
 (b) Explain how you would randomly assign the subjects to the four treatment groups. Then carry out your random assignment.

- 62. More rain for California?** The changing climate will probably bring more rain to California, but we don't know whether the additional rain will come during the winter wet season or extend into the long dry season in spring and summer. Kenwyn Suttle of the University of California at Berkeley and his coworkers carried out an experiment to study the effects of more rain in either season. They randomly assigned plots of open grassland to 3 treatments: added water equal to 20% of annual rainfall either during January to March (winter) or during April to June (spring), and no added water (control). Thirty-six circular plots of area 70 square meters were available (see the photo), of which 18 were used for this study. One response variable was total plant biomass, in grams per square meter, produced in a plot over a year.³⁵



- (a) Outline the design of the experiment. What is this type of design called?
 (b) Explain how you would randomly assign the experimental units to the three treatments. Then carry out your random assignment.

- 63. Treating prostate disease** A large study used records from Canada's national health care system to compare the effectiveness of two ways to treat prostate disease. The two treatments are traditional surgery and a new method that does not require surgery. The records described many patients whose doctors had chosen each method. The study found that patients treated by the new method were significantly more likely to die within 8 years.³⁶

- (a) Further study of the data showed that this conclusion was wrong. The extra deaths among patients who got the new method could be explained by lurking variables. What lurking variables might be confounded with a doctor's choice of surgical or nonsurgical treatment?
 (b) You have 300 prostate patients who are willing to serve as subjects in an experiment to compare the two methods. Write a few sentences describing how you would design this experiment.

- 64. Getting teachers to come to school** Elementary schools in rural India are usually small, with a single teacher. The teachers often fail to show up for work. Here is an idea for improving attendance: give the teacher a digital camera with a tamperproof time and date stamp and ask a student to take a photo of the teacher and class at the beginning and end of the day. Offer the teacher better pay for good attendance, verified by the photos. Will this work? Researchers obtained permission to use 120 rural schools in Rajasthan for an experiment to find out.³⁷

- (a) Explain why it would not be a good idea to offer better pay for good attendance to the teachers in all 120 schools and then to compare this year's attendance with last year's.
 (b) Write a few sentences describing how you would design this experiment.

- 65. Stronger players** A football coach hears that a new exercise program will increase upper-body strength better than lifting weights. He is eager to test this new program in the off-season with the players on his high school team. The coach decides to let his players choose which of the two treatments they will undergo for 3 weeks—exercise or weight lifting. He will use the number of push-ups a player can do at the end of the experiment as the response variable.

- (a) Which principle of experimental design does the coach's plan violate? Explain how this violation could lead to confounding.
 (b) Comment on the coach's choice of response variable.

- 66. Prayer and meditation** You read in a magazine that “nonphysical treatments such as meditation and prayer have been shown to be effective in controlled scientific studies for such ailments as high blood

pressure, insomnia, ulcers, and asthma." Explain in simple language what the article means by "controlled scientific studies." Why can such studies provide good evidence that meditation is an effective treatment for high blood pressure?

- 67. The effects of day care** Does day care help low-income children stay in school and hold good jobs later in life? The Carolina Abecedarian Project (the name suggests the ABCs) has followed a group of 111 children since 1972. Back then, these individuals were all healthy but low-income black infants in Chapel Hill, North Carolina. All the infants received nutritional supplements and help from social workers. Half were also assigned at random to an intensive preschool program.³⁸

- (a) Explain the purpose of each of the three experimental design principles.
- (b) Describe how each of these principles was used in this study.

- 68. Killing weeds** A biologist would like to determine which of two brands of weed killer is less likely to harm the plants in a garden at the university. Before spraying near the plants, the biologist decides to conduct an experiment using 24 individual plants. Which of the following two plans for randomly assigning the treatments should the biologist use? Why?

Plan A: Choose the 12 healthiest-looking plants. Apply Brand X weed killer to all 12 of those plants. Apply Brand Y weed killer to the remaining 12 plants.

Plan B: Choose 12 of the 24 plants at random. Apply Brand X weed killer to those 12 plants and Brand Y weed killer to the remaining 12 plants.

Do placebos really work? Researchers in Japan conducted an experiment on 13 individuals who were extremely allergic to poison ivy. On one arm, each subject was rubbed with a poison ivy leaf and told the leaf was harmless. On the other arm, each subject was rubbed with a harmless leaf and told it was poison ivy. All the subjects developed a rash on the arm where the harmless leaf was rubbed. Of the 13 subjects, 11 did not have any reaction to the real poison ivy leaf.³⁹

- (a) What was the placebo in this experiment?
- (b) Explain how the results of this study support the idea of a placebo effect.

- 70. Pain relief study** Fizz Laboratories, a pharmaceutical company, has developed a new drug for relieving chronic pain. Sixty patients suffering from arthritis and needing pain relief are available. Each patient will be treated and asked an hour later, "About what percent of pain relief did you experience?"

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(a) Why should Fizz not simply administer the new drug and record the patients' responses?

(b) Should the patients be told whether they are getting the new drug or a placebo? How would this knowledge probably affect their reactions?

- 71. Meditation for anxiety** An experiment that claimed to show that meditation lowers anxiety proceeded as follows. The experimenter interviewed the subjects and rated their level of anxiety. Then the subjects were randomly assigned to two groups. The experimenter taught one group how to meditate and they meditated daily for a month. The other group was simply told to relax more. At the end of the month, the experimenter interviewed all the subjects again and rated their anxiety level. The meditation group now had less anxiety. Psychologists said that the results were suspect because the ratings were not blind. Explain what this means and how lack of blindness could bias the reported results.

- 72. Testosterone for older men** As men age, their testosterone levels gradually decrease. This may cause a reduction in lean body mass, an increase in fat, and other undesirable changes. Do testosterone supplements reverse some of these effects? A study in the Netherlands assigned 237 men aged 60 to 80 with low or low-normal testosterone levels to either a testosterone supplement or a placebo. The report in the *Journal of the American Medical Association* described the study as a "double-blind, randomized, placebo-controlled trial."⁴⁰ Explain each of these terms to someone who knows no statistics.

- 73. Acupuncture and pregnancy** A study sought to determine whether the ancient Chinese art of acupuncture could help infertile women become pregnant.⁴¹ One hundred sixty healthy women undergoing treatment with artificial insemination were recruited for the study. Half of the subjects were randomly assigned to receive acupuncture treatment 25 minutes before embryo transfer and again 25 minutes after the transfer. The remaining 80 subjects were instructed to lie still for 25 minutes after the embryo transfer. **Results:** In the acupuncture group, 34 women became pregnant. In the control group, 21 women became pregnant.

- (a) Describe how the three principles of experimental design were addressed in this study.
- (b) The difference in the percent of women who became pregnant in the two groups is statistically significant. Explain what this means to someone who knows little statistics.
- (c) Explain why the placebo effect prevents us from concluding that acupuncture caused the difference in pregnancy rates.