Solutions to End-of-Chapter Problems

CHAPTER 1

1.1 Descriptive statistics organize, summarize, and communicate a group of numerical observations. Inferential statistics use sample data to make general estimates about the larger population.

1.2 A sample is a set of observations drawn from the population of interest, which we hope shares the same characteristics as the population of interest. A population includes all possible observations about which we'd like to know something.

1.3 The four types of variables are nominal, ordinal, interval, and ratio. A nominal variable is used for observations that have categories, or names, as their values. An ordinal variable is used for observations that have rankings (i.e., 1st, 2nd, 3rd . . .) as their values. An interval variable has numbers as its values; the distance (or interval) between pairs of consecutive numbers is assumed to be equal. Finally, a ratio variable meets the criteria for interval variables but also has a meaningful zero point. Interval and ratio variables are both often referred to as scale variables.

1.4 Statisticians use *scale* as another term for an interval or ratio measure. They also use scale as a word for many measurement tools, particularly those that involve a series of items that test-takers must complete.

1.5 Discrete variables can only be represented by specific numbers, usually whole numbers; continuous variables can take on any values, including those with great decimal precision (e.g., 1.597).

1.6 An independent variable is a variable that we either manipulate or observe to determine its effects on the dependent variable; a dependent variable is the outcome variable that we hypothesize to be related to, or caused by, changes in the independent variable.

1.7 A confounding variable (also called a confound) is any variable that systematically varies with the independent variable so that we cannot logically determine which variable affects the dependent variable. Researchers attempt to control confounding variables in experiments by randomly assigning participants to conditions. The hope with random assignment is that the confounding variable will be spread equally across the different conditions of the study, thus neutralizing its effects.

1.8 Reliability refers to the consistency of a measure. Validity refers to the extent to which a test actually measures what it was intended to measure. A measure that is valid absolutely must be reliable, but a reliable measure is not necessarily a valid one.

1.9 An operational definition specifies the operations or procedures used to measure or manipulate an independent or dependent variable.

1.10 In everyday language, people often use the word *experiment* to refer to something they are trying out to see what will happen. Researchers use the term to refer to a type of study in which participants are randomly assigned to levels of the independent variable.

1.11 When conducting experiments, the researcher randomly assigns participants to conditions or levels of the independent variable. When random assignment is not possible, such as when studying something like gender or marital status, correlational research is used. Correlational research allows us to examine how variables are related to each other; experimental research allows us to make assertions about how an independent variable causes an effect in a dependent variable.

1.12 In a between-groups research design, participants experience one, and only one, level of the independent variable. In a within-groups research design, all participants in the study experience all levels of the independent variable.

1.13
a. "This was an experiment" (not "This was a correlational study")
b. ". . . the independent variable of caffeine . . ." (not ". . . the dependent variable of caffeine. . . .")
c. "A university assessed the validity . . ." (not "A university assessed the reliability . . .")
d. "In a between-groups experiment . . ." (not "In a within-groups experiment . . .")

1.14
a. ". . . the nominal variable 'gender' . . ." (not ". . . the ordinal variable 'gender' . . .")
b. "A psychologist used a within-groups design . . ." (not "A psychologist used a between-groups design . . .")
c. ". . . the effects of the independent variable . . ." (not ". . . the effects of the confounding variable . . .")
d. "A researcher studied a sample of 20 rats . . ." (not "A researcher studied a population of 20 rats . . .")

1.15 The sample is the 100 customers who completed the survey. The population is all of the customers at the grocery store.

1.16
a. 130 people
b. All people living in urban areas in the United States
c. Descriptive statistic

d. Answers may vary, but one way is to sort people into groups such as "long distance walked," "medium distance walked," and "short distance walked."

e. Answers may vary, but pedometers could be used to measure steps taken or miles walked, both of which are scale measures.

1.17 **a.** 73 people

b. All people who shop in grocery stores similar to the one where data were collected

c. Inferential statistic

d. Answers may vary, but people could be labeled as having a "healthy diet" or an "unhealthy diet."

e. Answers may vary, but there could be groupings such as "no items," "a minimal number of items," "some items," and "many items."

f. Answers may vary, but the number of items could be counted or weighed.

1.18 Answers may vary, but on a national level, one could look at the rate of houses in foreclosure or the amount of government debt.

1.19 **a.** The independent variables are physical distance and emotional distance. The dependent variable is accuracy of memory.

b. There are two levels of physical distance (within 100 miles and 100 miles or farther) and three levels of emotional distance (knowing no one who was affected, knowing people who were affected but lived, and knowing someone who died).

c. Answers may vary, but accuracy of memory could be operationalized as the number of facts correctly recalled.

1.20 **a.** Skin tone

b. Severity of facial wrinkles

c. Three levels (light, medium, and dark)

1.21 **a.** The average weight for a 10-year-old girl was 77.4 pounds in 1963 and nearly 88 pounds in 2002.

b. No; the CDC would not be able to weigh every single girl in the United States because it would be too expensive and time consuming.

c. It is a descriptive statistic because it is a numerical summary of a sample. It is an inferential statistic because the researchers drew conclusions about the population's average weight based on this information from a sample.

1.22 **a.** The sample is the 60,000 people they studied.

b. The researchers would like to generalize their findings to the population of all Norwegians, or perhaps even more broadly.

1.23 **a.** Ordinal

b. Scale

c. Nominal

1.24 **a.** Ordinal

b. Scale

c. Scale

d. Nominal

e. Nominal

1.25 **a.** Discrete

b. Continuous

c. Discrete

d. Discrete

e. Continuous

1.26 **a.** A reliable test is one that provides consistent results. If you take the test twice, you should get the same results, an indication of reliability.

b. A valid test is one that measures what it intends to measure. This test has the stated intention of measuring personality. If in fact it is measuring personality accurately, then it is a valid test.

c. There are several possible answers to this question. The developers of this Web site might, for example, hypothesize that the region of the world in which one grew up predicts different personality profiles that are based on region.

d. The independent variable would be region and the dependent variable would be personality profile.

1.27 **a.** The independent variables are temperature and rainfall. Both are continuous, scale variables.

b. The dependent variable is experts' ratings. This is a discrete, scale variable.

c. The researchers wanted to know if the wine experts are consistent in their ratings—that is, if they're reliable.

d. This observation would suggest that Robert Parker's judgments are valid. His ratings seem to be measuring what they intend to measure—wine quality.

1.28 **a.** (1) Measured the distance between the well and the homes on a map; (2) measuring how many steps it takes to walk from a home to the well

b. (1) Described hair as short, medium, or very long; (2) measuring the length of the hair in inches

1.29 **a.** Age: teenagers and adults in their 30s; video game performance: final score on a video game or average reaction time on a video game task

b. Spanking: spanking and not spanking; violent behavior: parental measure of child aggression or number of aggressive acts observed in an hour of play

c. Meetings: go to meetings and participate online; weight loss: measured in pounds or kilograms, or by change in waist size

d. Studying: with others and alone; statistics performance: average test score for the semester or overall grade for the semester

e. Beverage: caffeinated and decaffeinated; time to fall asleep: minutes to fall asleep from when the participant goes to bed, or the actual time at which the participant falls asleep

1.30 **a.** The study could use a between-groups research design by assigning half the participants to exercise and half not to exercise.

b. Participants could be followed for several months to determine weight loss before the exercise program, then start the exercise program and be followed for several months to determine weight loss after the program.

c. There are several possible confounds. In the within-groups design, the participants are having their weight loss tracked, then starting an exercise program, then having their weight loss tracked some more. It is possible that the mere act of

tracking weight loss leads participants to implement weight-loss tactics other than exercise and that they start reaping the benefits of these tactics around the time the exercise program begins. Alternatively, it is possible that the no-exercise segment occurs in the winter and the exercise segment occurs in the spring. Many people gain a bit of weight during the winter and lose weight as summer—and bathing-suit season—approaches. It might be the weather, not the exercise program, that leads to weight loss.

1.31 **a.** An experiment requires random assignment to conditions. It would not be ethical to randomly assign some people to smoke and some people not to smoke, so this research had to be correlational.

b. Other unhealthy behaviors have been associated with smoking, such as poor diet and infrequent exercise. These other unhealthy behaviors might be confounded with smoking.

c. The tobacco industry could claim it was not the smoking that was harming people, but rather the other activities in which smokers tend to engage or fail to engage.

d. You could randomly assign people to either a smoking group or a nonsmoking group, and assess their health over time.

1.32 **a.** This research is correlational because participants could not be randomly assigned to be high in individualism or collectivism.

b. The sample is the 32 people who tested high for individualism and the 37 people who tested high for collectivism.

c. Answers may vary, but one hypothesis could be "On average, people high in individualism will have more relationship conflict than those high in collectivism."

d. Answers may vary, but one way to measure relationship conflict could be counting the number of disagreements or fights per month.

1.33 **a.** This is experimental because students are randomly assigned to one of the incentive conditions for recycling.

b. Answers may vary, but one hypothesis could be "Students fined for not recycling will report lower concerns for the environment, on average, than those rewarded for recycling."

1.34 **a.** Participants in the Millennium Cohort Study.

b. Parents in the United Kingdom, or possibly all parents globally.

c. This is a correlational study, as individuals were not randomly assigned to the condition of being a married couple or a cohabitating couple.

d. Marital status—married or cohabiting

e. Length of relationship

f. There are several possible answers to this question. For example, economic status or financial well-being may be a confounding factor, as those who are more likely to have the money to marry and raise a family may have fewer life stressors than those who have less money, do not marry, and choose to cohabitate. This variable could be operationalized and measured via household income.

1.35 **a.** Researchers could have randomly assigned some people who are HIV-positive to take the oral vaccine and other people who are HIV-positive not to take the oral vaccine. The second group would likely take a placebo.

b. This would have been a between-groups experiment because the people who are HIV-positive would have been in only one group: either vaccine or no vaccine.

c. This limits the researchers' ability to draw causal conclusions because the participants who received the vaccine may have been different in some way from those who did not receive the vaccine. There may have been a confounding variable that led to these findings. For example, those who received the vaccine might have had better access to health care and better sanitary conditions to begin with, making them less likely to contract cholera regardless of the vaccine's effectiveness.

d. The researchers might not have used random assignment because it would have meant recruiting participants, likely immunizing half, then following up with all of them. The researchers likely did not want to deny the vaccine to people who were HIV-positive because they might have contracted cholera and died without it.

e. We could have recruited a sample of people who were HIV-positive. Half would have been randomly assigned to take the oral vaccine; half would have been randomly assigned to take something that appeared to be an oral vaccine but did not have the active ingredient. They would have been followed to determine whether they developed cholera.

1.36 **a.** Ability level, graduate level (high school versus university), race

b. Wages

c. 12,000 men and women in the United States who were 14–22 years old in 1979

d. High school and college graduate men and women in the United States

e. Participants were studied over a period of time to measure change during that time period.

f. Age could be a confounding variable, as those who are older will have greater exposure to the various areas measured via the AFQT, in addition to the education they received at the college level.

g. Ability could be operationalized by having managers rate each participant's ability to perform his or her job. Another way ability could be operationalized is via high school and college GPA or a standardized ability test.

CHAPTER 2

2.1 Raw scores are the original data, to which nothing has been done.

2.2 To create a frequency table: (1) Determine the highest and lowest scores. (2) Create two columns; label the first with the variable name and label the second "Frequency." (3) List the full range of values that encompasses all the scores in the data set, from lowest to highest, even those for which the frequency is 0. (4) Count the number of scores at each value, and write those numbers in the frequency column.

2.3 A frequency table is a visual depiction of data that shows how often each value occurred; that is, it shows how many scores are at each value. Values are listed in one column, and the

numbers of individuals with scores at that value are listed in the second column. A grouped frequency table is a visual depiction of data that reports the frequency within each given interval, rather than the frequency for each specific value.

2.4 Statisticians might use *interval* to describe a type of variable. Interval variables have numbers as their values, and the distance (or interval) between numbers is assumed to be equal. Statisticians might also use *interval* to refer to the range of values to be used in a grouped frequency table, histogram, or polygon.

2.5 Bar graphs typically provide scores for nominal data, whereas histograms typically provide frequencies for scale data. Also, the categories in bar graphs do not need to be arranged in a particular order and the bars should not touch, whereas the intervals in histograms are arranged in a meaningful order (lowest to highest) and the bars should touch each other.

2.6 The *x*-axis is typically labeled with the name of the variable of interest. The *y*-axis is typically labeled "Frequency."

2.7 A histogram looks like a bar graph but is usually used to depict scale data, with the values (or midpoints of intervals) of the variable on the *x*-axis and the frequencies on the *y*-axis. A frequency polygon is a line graph, with the *x*-axis representing values (or midpoints of intervals) and the *y*-axis representing frequencies; a dot is placed at the frequency for each value (or midpoint), and the points are connected.

2.8 Visual displays of data often help us see patterns that are not obvious when we examine a long list of numbers. They help us organize the data in meaningful ways.

2.9 In everyday conversation, you might use the word *distribution* in a number of different contexts, from the distribution of food to a marketing distribution. A statistician would use *distribution* only to describe the way that a set of scores, such as a set of grades, is distributed. A statistician is looking at the overall pattern of the data—what the shape is, where the data tend to cluster, and how they trail off.

2.10 A normal distribution is a specific frequency distribution that is a bell-shaped, symmetric, unimodal curve.

2.11 With positively skewed data, the distribution's tail extends to the right, in a positive direction, and with negatively skewed data, the distribution's tail extends to the left, in a negative direction.

2.12 A floor effect occurs when there are no scores below a certain value; a floor effect leads to a positively skewed distribution because the lower part of the distribution is constrained.

2.13 A ceiling effect occurs when there are no scores above a certain value; a ceiling effect leads to a negatively skewed distribution because the upper part of the distribution is constrained.

2.14 4.98% and 2.27%

2.15 17.95% and 40.67%

2.16 3.69% and 18.11% are scale variables, both as counts and as percentages.

2.17 0.10% and 96.77%

2.18 1,889.00, 2.65, and 0.08

2.19 0.04, 198.22, and 17.89

2.20 **a.** The full range is the maximum (27) minus the minimum (0), plus 1, which equals 28.

b. Five

c. The intervals would be 0–4, 5–9, 10–14, 15–19, 20–24, and 25–29.

2.21 The full range of data is 68 minus 2, plus 1, or 67. The range (67) divided by the desired seven intervals gives us an interval size of 9.57, or 10 when rounded. The seven intervals are: 0–9, 10–19, 20–29, 30–39, 40–49, 50–59, and 60–69.

2.22 37.5, 52.5, and 67.5

2.23 25 shows

2.24 Twelve countries had between 2 and 10 first- or second-place World Cup finishes.

2.25 Serial killers would create positive skew, adding high numbers of murders to the data that are clustered around 1.

2.26 People convicted of murder are assumed to have killed at least one person, so observations below one are not seen, which creates a floor effect.

2.27 **a.** For the college population, the range of ages extends farther to the right (with a larger number of years) than to the left, creating positive skew.

b. The fact that youthful prodigies have limited access to college creates a sort of floor effect that makes low scores less possible.

2.28 **a.** Assuming that most people go for the maximum number of friends, for the range of Facebook friends, the number of friends extends farther to the left (with fewer number of friends) than to the right, creating a negative skew.

b. The fact that Facebook cuts off or limits the number of friends to 5000 means there is a ceiling effect that makes higher scores impossible.

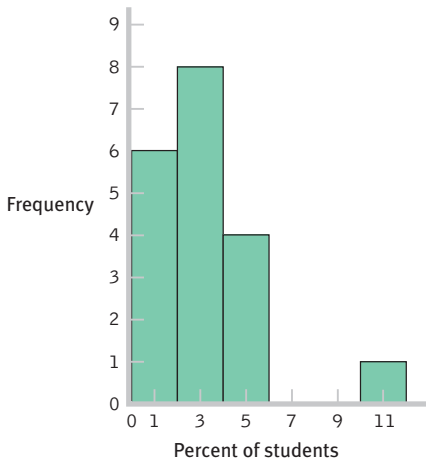
2.29 **a.**

PERCENTAGE	FREQUENCY	PERCENTAGE
10	1	5.26
9	0	0.00
8	0	0.00
7	0	0.00
6	0	0.00
5	2	10.53
4	2	10.53
3	4	21.05
2	4	21.05
1	5	26.32
0	1	5.26

b. 10.53% of these schools had exactly 4% of their students report that they wrote between 5 and 10 twenty-page papers that year.

c. This is not a random sample. It includes schools that chose to participate in this survey and opted to have their results made public.

d.



e. One

f. The data are clustered around 1% to 4%, with a high outlier, 10%.

2.30 **a.**

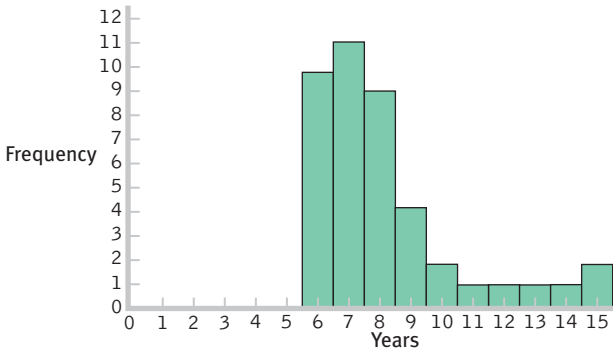
YEARS TO COMPLETE	FREQUENCY
15	2
14	1
13	1
12	1
11	1
10	2
9	4
8	9
7	11
6	10

b. 30

c. A grouped frequency table is not necessary here. These data are relatively easy to interpret in the frequency table. Grouped frequency tables are useful when the list of data is long and difficult to interpret.

d. These data are clustered around 6 to 8 years, with a long tail of data out to a greater number of years to complete. These data show positive skew.

e.



f. Eight

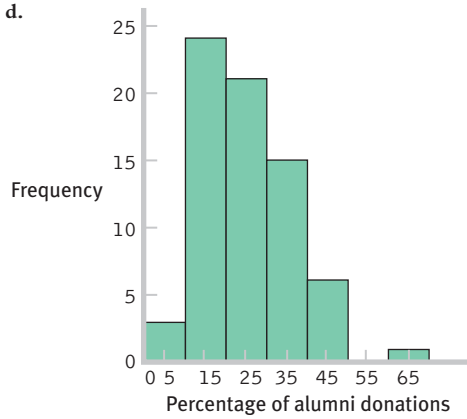
2.31 **a.** The variable of alumni giving was operationalized by the percentage of alumni who donated to a given school. There are several other ways it could be operationalized. For example, the data might consist of the total dollar amount or the mean dollar amount that each school received.

b.

INTERVAL	FREQUENCY
60–69	1
50–59	0
40–49	6
30–39	15
20–29	21
10–19	24
0–9	3

c. There are many possible answers to this question. For example, we might ask whether sports team success predicts alumni giving or whether the prestige of the institution is a factor (the higher the ranking, the more alumni who donate).

d.



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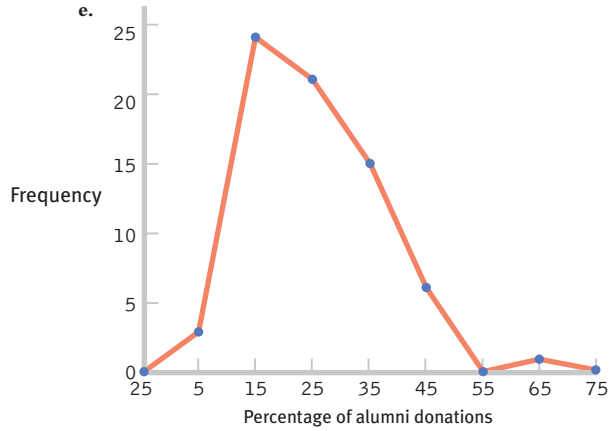
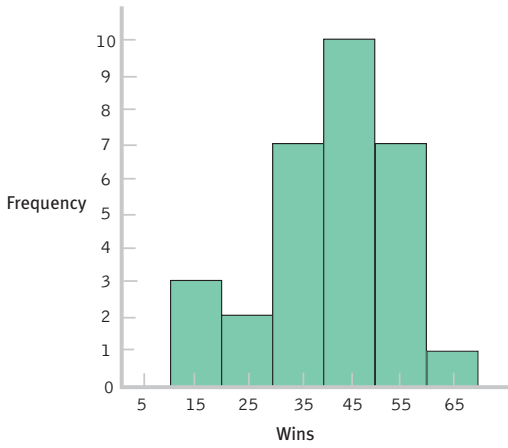


f. There is one unusual score—61. The distribution appears to be positively skewed. The center of the distribution seems to be in the 10–29 range.

2.32 **a.**

INTERVAL	FREQUENCY
60–69	1
50–59	7
40–49	10
30–39	7
20–29	2
10–19	3

b.



c. The summary will differ for each student but should include the following information: the data appear to be roughly symmetric, maybe a bit negatively skewed.

d. There are many possible answers to this question. For example, one might ask whether teams with older players do better or worse than those with younger players. Another study might examine whether team budget relates to wins; there's a salary cap, but some teams might choose to pay the "luxury tax" in order to spend more. Does spending make a difference?

2.33 **a.** Extroversion scores are most likely to have a normal distribution. Most people would fall toward the middle, with some people having higher levels and some having lower levels.

b. The distribution of finishing times for a marathon is likely to be positively skewed. The floor is the fastest possible time, a little over 2 hours; however, some runners take as long as 6 hours or more. Unfortunately for the very, very slow but unbelievably dedicated runners, many marathons shut down the finish line 6 hours after the start of the race.

c. The distribution of numbers of meals eaten in a dining hall in a semester on a three-meal-a-day plan is likely to be negatively skewed. The ceiling is three times per day, multiplied by the number of days; most people who choose to pay for the full plan would eat many of these meals. A few would hardly ever eat in the dining hall, pulling the tail in a negative direction.

2.34 **a.** You would present individual data values because the few categories of eye color would result in a readable list. Frequency table

b. You would present grouped data because it is possible for each person to use a different amount of minutes and such a long list would be unreadable. Grouped frequency table, histogram, or frequency polygon

c. You would present grouped data because time to complete carried out to seconds would produce too many unique numbers to organize meaningfully without groupings. Grouped frequency table, histogram, or frequency polygon

d. You would present individual data values because number of siblings tends to take on limited values. Frequency table, histogram, or frequency polygon

2.35 **a.**

INTERVAL	FREQUENCY
300–339	4
260–299	7
220–259	9
180–219	3

b. This is not a random sample because only résumés from those applying for a receptionist position in his office were included in the sample.

c. This information lets the trainees know that most of these résumés contained between 220 and 299 words. This analysis tells us nothing about how word count might relate to quality of résumé.

2.36 **a.** A histogram of grouped frequencies

b. Approximately 32

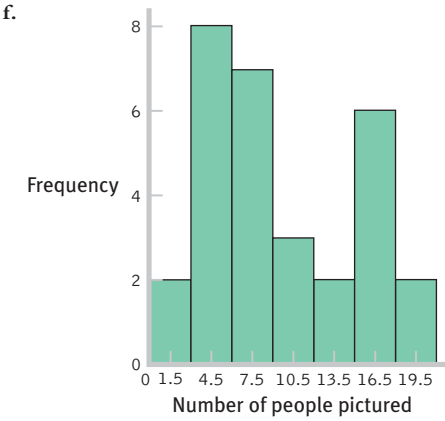
c. Approximately 27

d. Two questions we might ask are (1) How close is the person to those photographed?, and (2) What might account for the two peaks in these data?

e.

INTERVAL	FREQUENCY
18–20	2
15–17	6
12–14	2
9–11	3
6–8	7
3–5	8

f.

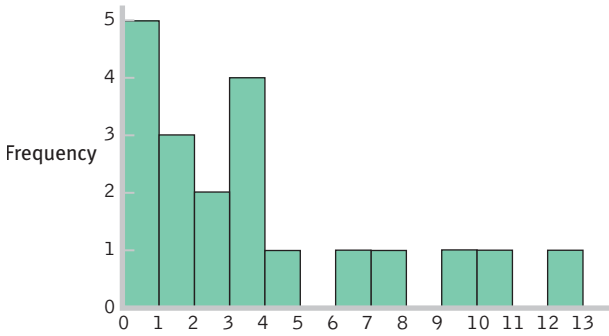


g. The data have two high points around 3–9 and 15–18. We can see that the data are asymmetric to the right, creating positive skew.

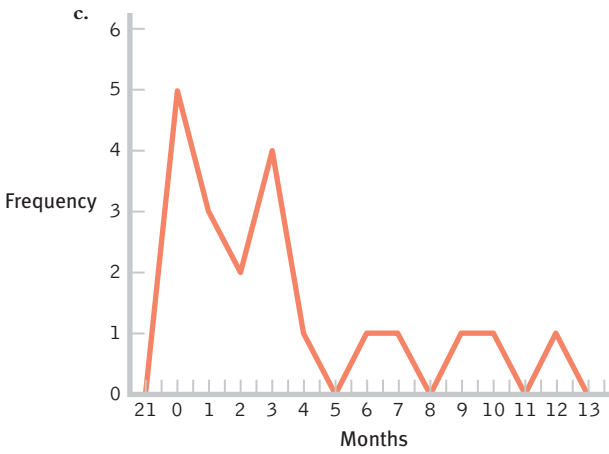
2.37 **a.**

MONTHS	FREQUENCY	PERCENTAGE
12	1	5
11	0	0
10	1	5
9	1	5
8	0	0
7	1	5
6	1	5
5	0	0
4	1	5
3	4	20
2	2	10
1	3	15
0	5	25

b.



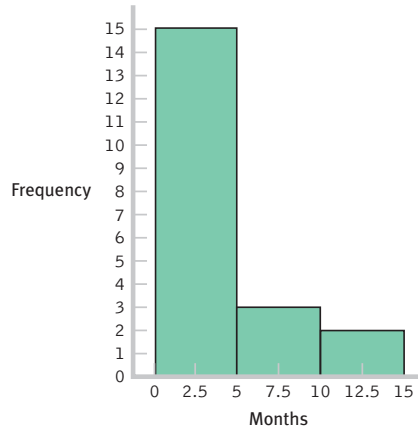
c.



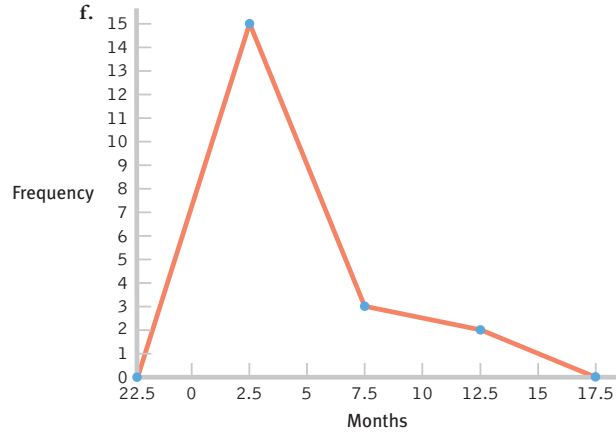
d.

INTERVAL	FREQUENCY
10–14 months	2
5–9 months	3
0–4 months	15

e.



f.



g. These data are centered around the 3-month period, with positive skew extending the data out to the 12-month period.

h. The bulk of the data would need to be shifted from the 3-month period to approximately 12 months, so that group of women might be the focus of attention. Perhaps early contact at the hospital and at follow-up visits after birth would help encourage mothers to breast-feed, and to breast-feed longer. One could also consider studying the women who create the positive skew to learn what unique characteristics or knowledge they have that influenced their behavior.

2.38 **a.** The column for faculty shows a high point from 0–7 friends.

b. The column for students shows two high points around 4–11 and 16–23, with some high outliers creating positive skew.

c. The independent variable would be status, with two levels (faculty, student).

d. The dependent variable would be number of friends.

e. A confounding variable could be age, as faculty are older than students and tend to be less involved in social activities or situations where making friends is common.

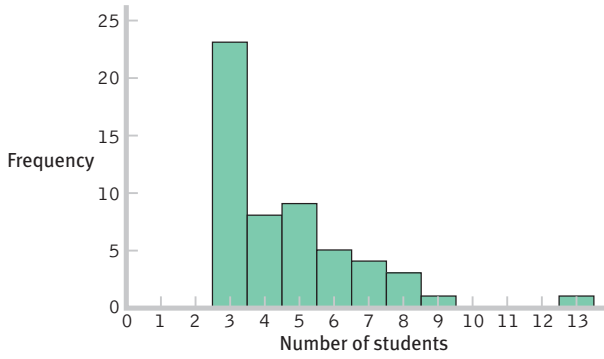
f. The dependent variable could be operationalized as the number of people who appear in photographs on display

in dorm rooms and offices across campus, as was done for this study. There are several additional ways these data could be operationalized. One way would be to record the number of Facebook friends each person has. Another way would be to count the number of friends each person reports interacting with on a regular basis. This latter method of measuring number of friends is more likely to reveal the quality of friendship via the amount of interaction.

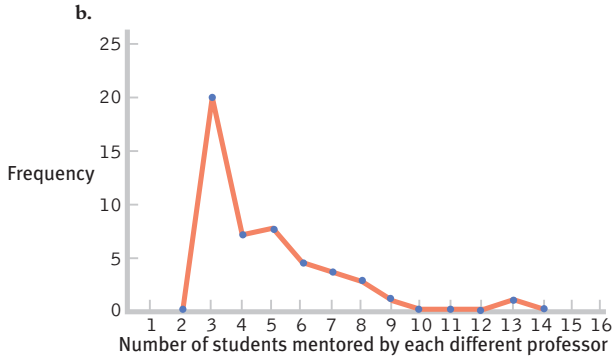
2.39

FORMER STUDENTS NOW IN TOP JOBS	FREQUENCY	PERCENTAGE
13	1	1.85
12	0	0.00
11	0	0.00
10	0	0.00
9	1	1.85
8	3	5.56
7	4	7.41
6	5	9.26
5	9	16.67
4	8	14.81
3	23	42.59

a.



b.



c. This distribution is positively skewed.

d. The researchers operationalized the variable of mentoring success as numbers of students placed into top professorial positions. There are many other ways this variable could have been operationalized. For example, the researchers might have counted numbers of student publications while in graduate school or might have asked graduates to rate their satisfaction with their graduate mentoring experiences.

e. The students might have attained their professor positions because of the prestige of their advisor, not because of his mentoring.

f. There are many possible answers to this question. For example, the attainment of a top professor position might be predicted by the prestige of the institution, the number of publications while in graduate school, or the graduate student's academic ability.

CHAPTER 3

3.1 The biased scale lie, the sneaky sample lie, the interpolation lie, the extrapolation lie, and the inaccurate values lie.

3.2 (1) Organize the data by participant; each participant will have two scores, one on each scale variable. (2) Label the horizontal *x*-axis with the name of the independent variable and its possible values, starting with 0 if practical. (3) Label the vertical *y*-axis with the name of the dependent variable and its possible values, starting with 0 if practical. (4) Make a mark on the graph above each study participant's score on the *x*-axis and across from his or her score on the *y*-axis.

3.3 To convert a scatterplot to a range-frame, simply erase the axes below the minimum score and above the maximum score.

3.4 A linear relation between variables means that the relation between variables is best described by a straight line.

3.5 With scale data, a scatterplot allows for a helpful visual analysis of the relation between two variables. If the data points appear to fall approximately along a straight line, this indicates a linear relation. If the data form a line that changes direction along its path, a nonlinear relation may be present. If the data points show no particular relation, it is possible that the two variables are not related.

3.6 A line graph is used to illustrate the relation between two scale variables. One type of line graph is based on a scatterplot and allows us to construct a line of best fit that represents the predicted *y* scores for each *x* value. A second type of line graph allows us to visualize changes in the values on the *y*-axis over time. A time plot, or time series plot, is a specific type of line graph. It is a graph that plots a scale variable on the *y*-axis as it changes over an increment of time (e.g., second, day, century) recorded on the *x*-axis.

3.7 A bar graph is a visual depiction of data in which the independent variable is nominal or ordinal and the dependent variable is scale. Each bar typically represents the mean value of the dependent variable for each category. A Pareto chart is a specific type of bar graph in which the categories along the *x*-axis are ordered from highest bar on the left to lowest bar on the right.

3.8 Bar graphs typically depict summary statistics, such as frequencies or averages, for several different levels of one or more nominal or ordinal independent variables. Histograms typically depict frequencies for different values of one scale variable. Bars represent counts or percentages for different values of a scale variable or for different intervals of that scale variable.

3.9 A pictorial graph is a visual depiction of data typically used for a nominal independent variable with very few levels (categories) and a scale dependent variable. Each level uses a picture or symbol to represent its value on the scale dependent variable. A pie chart is a graph in the shape of a circle, with a slice for every level. The size of each slice represents the proportion (or percentage) of each category. In most cases, a bar graph is preferable to a pictorial graph or a pie chart.

3.10 Bar graphs are straightforward presentations of data, whereas the elements of pictorial graphs and pie charts can often distract from the data being presented. Also, mistakes in presentation style are much more common for pictorial graphs and pie charts.

3.11 The independent variable typically goes on the horizontal *x*-axis and the dependent variable goes on the vertical *y*-axis.

3.12 Whenever possible, graph axes should start at 0, although sometimes it is not practical to start at 0. For example, when the data do not contain low values (and including 0 would minimize the depiction of the actual data), we should use cut marks to indicate axes that do not start at 0.

3.13 Moiré vibrations are any visual patterns that create a distracting impression of vibration and movement. A grid is a background pattern, almost like graph paper, on which the data representations, such as bars, are superimposed. Ducks are features of the data that have been dressed up to be something other than merely data.

3.14 Geographic information systems are particularly powerful for analyzing demographic patterns or demographic differences in a variable. Knowing how several variables change over geographic regions could lead researchers to detect important relations among variables.

3.15 Total dollars donated per year is scale data. A time plot would nicely show how donations varied across years.

3.16 Sorting people into the categories of "alumni who donated money" and "alumni who did not donate money" creates nominal data. We would use a bar graph to depict the numbers of alumni who did and did not donate.

3.17
a. The independent variable is gender and the dependent variable is video game score.
b. Nominal
c. Scale
d. The best graph for these data would be a bar graph because there is a nominal independent variable and a scale dependent variable.

3.18 Nonlinear, because the data change direction around 4.00 on the *x*-axis.

3.19 Linear, because the data could be fit with a line drawn from the upper-left to the lower-right corner of the graph.

3.20 These graphs are missing titles and axis labels. The axes are also missing 0 values.

3.21
a. Bar graph
b. Line graph; more specifically, a time plot
c. The *y*-axis should go down to 0.
d. The lines in the background are grids, and the three-dimensional effect is a type of duck.
e. 3.20%, 3.22%, 2.80%
f. If the *y*-axis started at 0, all of the bars would appear to be about the same height. The differences would be minimized.

3.22 These data have a minimum value of 273 and a maximum value of 342. Because the minimum value is far from 0, it is not practical to have the axis start at 0, so cut marks would be used. (However, we would include the full range of data—0 to 342—if omitting some of these numbers would be misleading.) We might then include every 10th value, starting at 270:

270, 280, 290, 300, 310, 320, 330, 340, 350

3.23 The minimum value is 0.04 and the maximum is 0.36, so the axis could be labeled from 0.00 to 0.40. We might choose to mark every 0.05 value:

0.00, 0.05, 0.10, 0.15, 0.20, 0.25, 0.30, 0.35, and 0.40

3.24
a. The highest life expectancy is 82 years. The fertility rate associated with the highest life expectancy is 0.96.
b. Yes, this seems to be a linear relation, with the data fitting a line moving from the upper-left to the lower-right corner of the graph. As the fertility rate increases, the life expectancy at birth decreases.

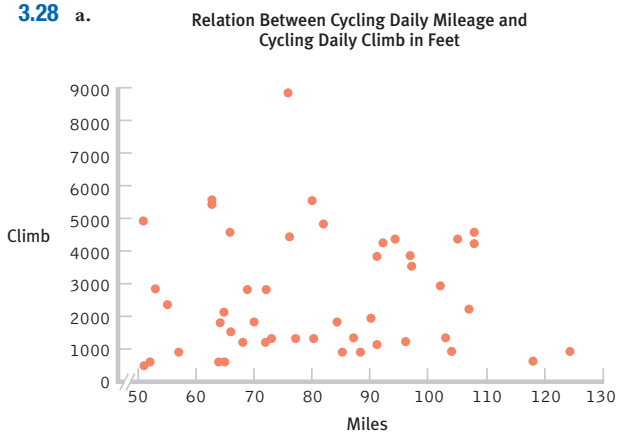
3.25
a. The independent variable is height and the dependent variable is attractiveness. Both are scale variables.
b. The best graph for these data would be a scatterplot (which also might include a line of best fit if the relation is linear) because there are two scale variables.
c. It would not be practical to start the axis at 0. With the data clustered from 58 to 71 inches, a 0 start to the axis would mean that a large portion of the graph would be empty. We would use cut marks to indicate that the axis did not include all values from 0 to 58. (However, we would include the full range of data—0 to 71—if omitting some of these numbers would be misleading.)

3.26
a. The independent variable is time (i.e., week) and the dependent variable is mean depression level.
b. Both variables are scale.
c. The best graph for these data would be a time plot because the social worker is tracking depression levels over a period of time (20 weeks).

3.27
a. The independent variable is country and the dependent variable is male suicide rate.
b. Country is a nominal variable and suicide rate is a scale variable.
c. The best graph for these data would be a Pareto chart. Because there are 20 categories along the *x*-axis, it is best to arrange them in order from highest to lowest.

d. A time series plot could show year on the *x*-axis and suicide rate on the *y*-axis. Each country would be represented by a different color line.

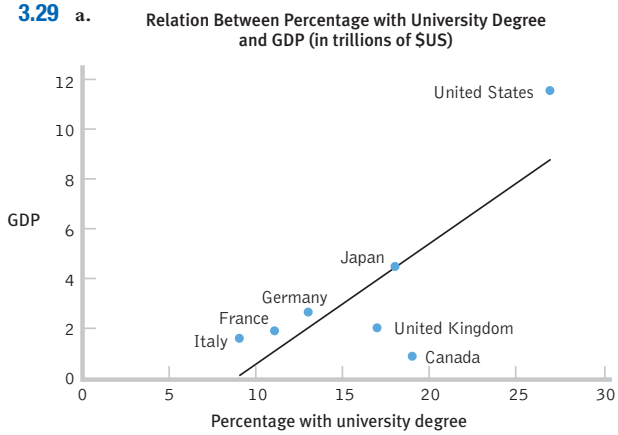
3.28 **a.**



b. For the most part, the points on the scatterplot do not seem to indicate any particular relation, whether linear or curvilinear. Low-mileage days (50 to 70 miles) have some low-climb and some high-climb days, and mid-mileage days (90 to 110 miles) have some low-climb and some high climb days. Only the two very long mileage days (around 120 miles) have low climbs, perhaps indicating a tiny relation.

c. The cyclists experience both the mileage and climbs as difficult and tend to notice days on which both are high. The organizers want to convince cyclists to sign up and pay the trip costs so they can make money; a promise that long mileage days won't have big climbs helps them recruit cyclists. The staff have no vested interest either way.

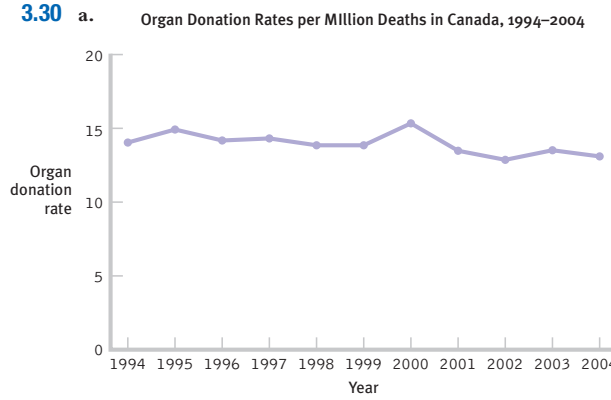
3.29 **a.**



b. The percentage of residents with a university degree appears to be related to GDP. As the percentage with a university degree increases, so does GDP.

c. It is possible that an educated populace has the skills to make that country productive and profitable. Conversely, it is possible that a productive and profitable country has the money needed for the populace to be educated.

3.30 **a.**



b. These data suggest that, although there are some fluctuations, a slight decrease in organ donation seems to have taken place between 1994 and 2004.

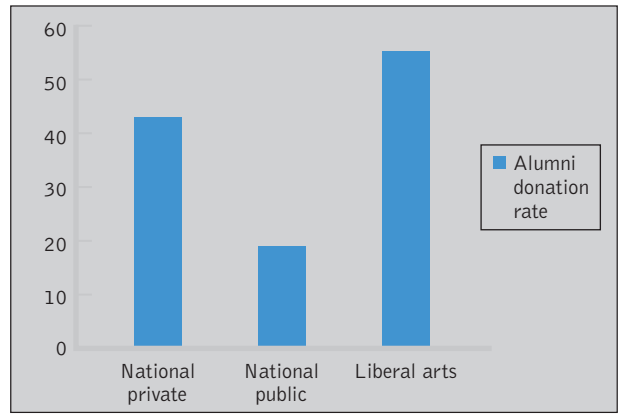
c. There are many possible answers to this question. As one example, you might be interested in how characteristics of families or types of deaths distinguish between agreeing to and declining to donate.

3.31 **a.** The independent variable is type of academic institution. It is nominal; the levels are private national, public national, and liberal arts.

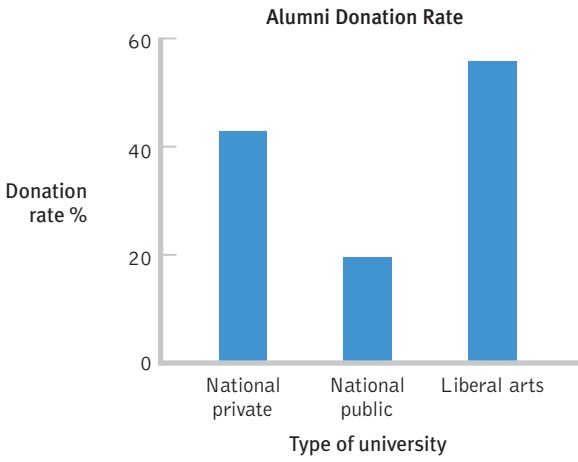
b. The dependent variable is alumni donation rate. It is a scale variable; the units are percentages, and the range of values is from 9 to 66.

c. The defaults will differ, depending on which software is used.

Here is one example.



d. The redesigns will differ, depending on which software is used. In this example, we have added a clear title, labeled the *x*-axis, omitted the key, and labeled the *y*-axis (being sure that it reads from left to right). We also toned down the unnecessary color in the background and cut some of the extra numbers from the *y*-axis. Finally, we removed the black box from around the graph.



e. These data suggest that a higher percentage of alumni of liberal arts colleges than of national private or national public universities donate to their institutions. Moreover, a higher percentage of alumni of national private universities than of national public universities donate.

f. There are many possible answers to this question. One might want to identify characteristics of alumni who donate, methods of soliciting donations that result in the best outcomes, or characteristics of universities within a given category (e.g., liberal arts) that have the highest rates.

g. Pictures could be used instead of bars. For example, dollar signs might be used to represent the three quantities.

h. If the dollar signs become wider as they get taller, as often happens with pictorial graphs, the overall size would be proportionally larger than the increase in donation rate it is meant to represent. A bar graph is not subject to this problem because graphmakers are not likely to make bars wider as they get taller.

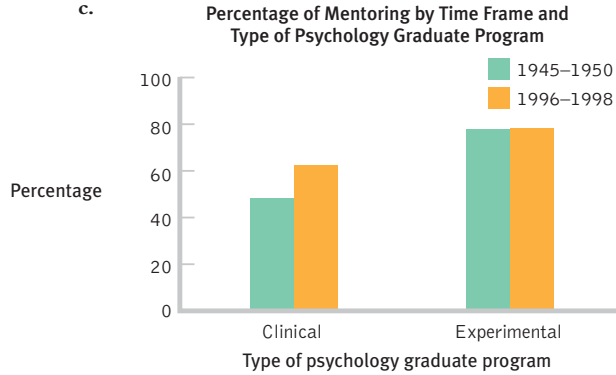
3.32 **a.** A Pareto chart is organized from the highest bar to the lowest bar, whereas a bar graph might be organized in a number of different ways (e.g., alphabetical).

b. The Pareto chart allows us to make comparisons more easily than does the bar graph. Moreover, we can very easily identify the countries with the highest and lowest GDP.

3.33 **a.** One independent variable is time frame; it has two levels: 1945–1950 and 1996–1998. The other independent variable is type of graduate program; it also has two levels: clinical psychology and experimental psychology.

b. The dependent variable is percentage of graduates who had a mentor while in graduate school.

c.



d. These data suggest that clinical psychology graduate students were more likely to have been mentored if they were in school in the 1996–1998 time frame than if they were in school during the 1945–1950 time frame. There does not appear to be such a difference among experimental psychology students.

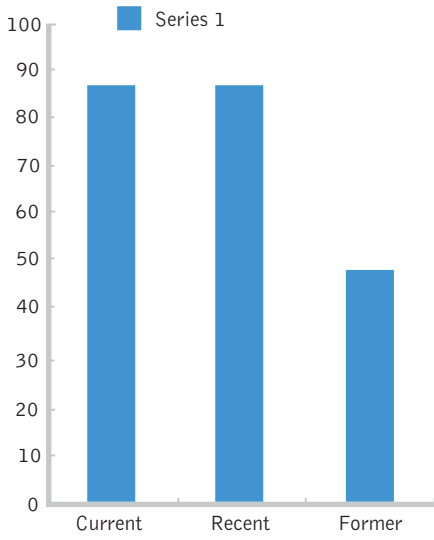
e. This was not a true experiment. Students were not randomly assigned to time period or type of graduate program.

f. A time series plot would be inappropriate with so few data points. It would suggest that we could interpolate between these data points. It would suggest a continual increase in the likelihood of being mentored among clinical psychology students, as well as a stable trend, albeit at a high level, among experimental psychology students.

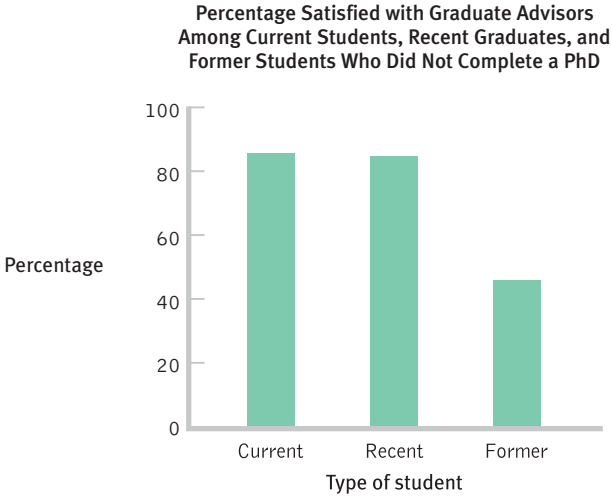
g. The story based on two time points might be falsely interpreted as a continual increase of mentoring rates for the clinical psychology students and a plateau for the experimental psychology students. The expanded data set suggests that the rates of mentoring have fluctuated over the years. Without the four time points, we might be seduced by interpolation into thinking that the two scores represent the end points of a linear trend. We cannot draw conclusions about time points for which we have no data—especially when we have only two points, but even when we have more points.

3.34 A pie chart would include the four percentages as slices, but it might be difficult to make comparisons, particularly between percentages similar in size (e.g., 9% and 5%). A bar graph allows for easier comparisons among categories than does a pie chart.

3.35 **a.** The details will differ, depending on the software used. Here is one example.



b. The default options that students choose to override will differ. For the bar graph here, we (1) added a title, (2) labeled the *x*-axis, (3) labeled the *y*-axis, (4) once we created the label on the *y*-axis, we rotated it so that it reads from left to right, (5) eliminated the box around the whole graph, and (6) eliminated the unnecessary key.



3.36 The examples will differ for each student. Correct answers will include the following types of variables.

a. Frequency polygon: one scale variable; for example, on the *x*-axis, times for rats to complete a maze, and on the *y*-axis, frequencies for each time

b. Line graph (line of best fit): two scale variables; for example, on the *x*-axis, hours of maze-training for rats, and on the *y*-axis, predicted times for rats to complete a maze

c. Bar graph (one independent variable): one nominal or ordinal independent variable, such as gender of rat, on the *x*-axis, and one scale dependent variable, such as time to complete a maze, on the *y*-axis

d. Scatterplot: two scale variables; for example, on the *x*-axis, hours of maze-training for rats, and on the *y*-axis, times for rats to complete a maze

e. Time series plot: one time-related independent variable, such as year, on the *x*-axis, and one scale dependent variable, such as mean GPA of incoming students, on the *y*-axis,

f. Pie chart: Trick question! Don't use one; use a bar graph instead.

g. Bar graph (two independent variables): two nominal or ordinal independent variables, such as gender of rat and reinforcement schedule for rat, on the *x*-axis, and a scale dependent variable, such as time to complete a maze, on the *y*-axis

3.37 Each student's advice will differ. The following are examples of advice.

a. The shrinking doctor: Replace the pictures with bars. Space the 3 years out in relation to their actual values (in the art shown, 1964 and 1975 are a good deal farther apart than are 1975 and 1990). Make the main title more descriptive.

b. Workforce participation: Eliminate all the pictures. A falling line in the art shown indicates an *increase* in percentage; notice that 40% is at the top and 80% is at the bottom. Make the *y*-axis go from highest to lowest, starting from 0. Make the lines easier to compare by eliminating the three-dimensional effect. Make it clear where the data point for each year falls by including a tick mark for each number on the *x*-axis.

3.38 The articles and subsequent responses will be different for each student.

3.39 **a.** The graph proposes that Type I regrets of action are initially intense but decline over the years, while Type II regrets of inaction are initially mild but become more intense over the years.

b. There are two independent variables: type of regret (a nominal variable) and age (a scale variable). There is one dependent variable: intensity of regrets (also a scale variable).

c. This is a graph of a theory. No data have been collected, so there are no statistics of any kind.

d. The story that this theoretical relation suggests is that regrets over things a person has done are intense shortly after the actual behavior but decline over the years. In contrast, regrets over things a person has not done but wishes they had are initially low in intensity but become more intense as the years go by.

3.40 **a.** This is a time plot. The researchers chose this type of graph because they wanted to show changes in the number of psychology degrees over time.

b. This graph suggests a fairly large increase in bachelor's degrees over time, with smaller increases in master's degrees and doctoral degrees.

c. There are two independent variables. One is type of degree, with three levels: bachelor's, master's, and doctoral. It could be considered ordinal. The other independent variable is year; it is a scale variable. The dependent variable is number of psychology degrees; it is also a scale variable.

d. There are several possible answers to this question. For example, the *y*-axis starts at 0, there is a clear title, and all labels read from left to right.

e. There are several possible answers to this question. For example, the graph creator should have labeled the *x*-axis. The *y*-axis is too "busy"; intervals of 10,000 would be better.

f. There are several possible answers to this question. For example, we could track percentage out of all such degrees (e.g., percentage of psychology bachelor's degrees conferred out of *all* bachelor's degrees conferred).

g. There are several possible answers to this question. For example, we might examine what types of careers psychology undergraduates pursue that do not require a master's or doctoral degree in psychology.

3.41 **a.** When first starting therapy, the client showed a decline, as measured by the Mental Health Index (MHI). After 8 weeks of therapy, this trajectory reversed and there was a week-to-week improvement in the client's MHI.

b. There are many possible answers. For example, the initial decline in the client's MHI may have been due to difficulties in adapting to therapy that were overcome as the client and therapist worked together. Alternatively, it may be that the client initially entered therapy due to difficult life circumstances that continued through the first weeks of therapy but resolved after several weeks.

c. Because the client is not beneath the failure boundary, and because the client experienced improvement over the last few weeks of therapy, it may be beneficial for the client to continue in therapy.

3.42 **a.** Density of traffic is represented by the thickness of the colored lines across the roads. The flow of traffic is represented by the color of the lines.

b. Answers to this question will vary, depending on the time of day and the exact traffic conditions.

c. This interactive graph allows anyone to see up-to-the-minute local, regional, and national traffic conditions. Traditional graphing techniques do not allow such up-to-date information on demand.

3.43 **a.** The independent variable is song type, with two levels: romantic song and nonromantic song.

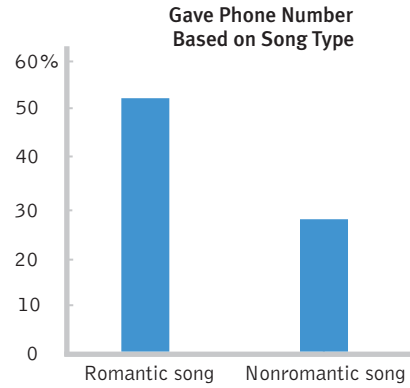
b. The dependent variable is dating behavior.

c. This is a between-groups study because each participant is exposed to only one level or condition of the independent variable.

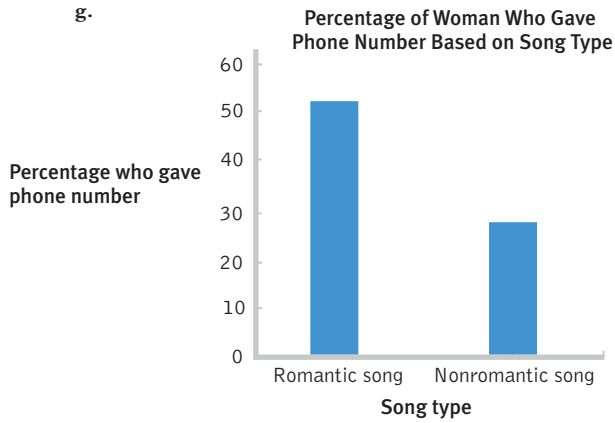
d. Dating behavior was operationalized by giving one's phone number to an attractive person of the opposite sex. This may not be a valid measure of dating behavior, as we do not know if the participant actually intended to go on a date with the researcher. Giving one's phone number might not necessarily indicate an intention to date.

e. We would use a bar graph because there is one nominal independent variable and one scale dependent variable.

f. The default graph will differ, depending on which software is used. Here is one example:



g.



3.44 **a.** Sunday at midnight

b. Saturday at 9 A.M.

c. Are people happiest on Saturdays? The independent variable is day of the week. The dependent variables are positive attitude and negative attitude.

d. Mood is operationalized as positive or negative attitudes expressed in tweets sent via Twitter. This may not be a valid measure of mood, as an expression of one's attitude may not reflect someone's actual mood states.

e. This finding that people have the highest average negative mood on Sunday nights fits with the hypothesis that people are happiest on Saturdays. Because Sunday night is the night before work or before school resumes for many people, we might study whether the imminent start to the work and school week is affecting people's moods.

CHAPTER 4

4.1 The mean is the arithmetic average of a group of scores; it is calculated by summing all the scores and dividing by the total number of scores. The median is the middle score of all the scores when a group of scores is arranged in ascending order. If there is no single middle score, the median is the mean of the two middle scores. The mode is the most common score of all the scores in a group of scores.