GLOBAL EDITION

Research Methods, Design, and Analysis

TWELFTH EDITION

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PEARSON

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Population
The full set of elements from which the sample is selected

Sampling
The process of drawing a sample from a population

Representative sample
A sample that resembles the population

Equal probability of selection method (EPSEM)
Sampling method in which each individual element has an equal probability of selection into the sample

Statistic
A numerical characteristic of sample data

Parameter
A numerical characteristic of a population

Sampling error
Differences between sample values and the true population parameter

Census
Collection of data from everyone in the population

basic unit of sampling. The **population** is the full set of elements or people from which you are sampling. **Sampling** refers to drawing elements from a population to obtain a sample. The usual goal of sampling is to obtain a **representative sample**, which is a sample that is similar to the population on all characteristics (except that it includes fewer people, because it is a sample rather than the complete population). Metaphorically, a perfectly representative sample would be a "mirror image" of the population from which it was selected (except that it would include fewer people).

When you want your sample to represent or "mirror" the population, the best way is to use an **equal probability of selection method (EPSEM)**. An EPSEM is any sampling method in which each individual member of the population has an equal chance of being selected for inclusion in the sample. If everyone has an equal chance, then the kinds of people in large groups will be selected more often and the kinds of people in small groups will be selected less often, but every single individual person will have the same chance of inclusion. For example, if the composition of a population is 55% female, 75% young adults aged 18–28, and 80% individuals who have completed an introductory psychology course, then a representative sample would have approximately the same percentages on these characteristics. Approximately 55% of the *sample* participants would be female, approximately 75% would be young adults, and approximately 80% would have completed an introductory psychology course. You will learn presently that there are several equal probability sampling methods, but simple random sampling, perhaps, is the most common (Peters & Eachus, 2008).

Once you collect data from the research participants in your sample, you must analyze the data. During analysis, you will determine characteristics of your sample such as the mean and variance on variables, as well as relationships between variables; these results calculated from your sample data are known as statistics. A **statistic** is a numerical characteristic of the sample data. For example, perhaps the mean income in a particular sample (i.e., the statistic) is $56,000 per year. Oftentimes a researcher also wants to make statements about population characteristics based on the sample results, such as an estimate of the population mean based on the sample mean. In statistical jargon, the researcher wants to make statements about parameters. A **parameter** is a numerical characteristic of a population. Perhaps the mean income in the entire population (i.e., the parameter) is $51,323 per year.

Notice that our sample mean and population mean income levels are different ($56,000 in the sample vs. $51,323 in the population). That's the typical situation in sampling, even when the best sampling methods are used. The term **sampling error** is used to refer to the difference between the value of a sample statistic and the value of the population parameter. In our case of annual income, the sampling error was equal to $4,677 (i.e., 56,000−51,323 = 4,677). A key point is that some error is always present in sampling. With random sampling methods, errors are random rather than being systematically wrong (and, potentially, the errors will be relatively small if large samples are drawn). When error is random, as in random sampling, the average of all possible samples is equal to the true population parameter, and the values of the samples vary randomly around the true parameter. This is the best we can hope for with sampling. If you need to have no sampling error, you will have to avoid sampling and conduct a **census**—you will have to collect

data from everyone in the population. Conducting a census is rarely an option, however, because most populations are very large, and it would be too expensive.

Sampling frame
A list of all the elements in a population

Most sampling methods require that you have a list of the people who are in the population. This list is called a **sampling frame**. An example of a sampling frame is shown in Figure 5.1. This sampling frame includes all the presidents of the American Psychological Association since its founding in 1892. The

FIGURE 5.1
A sampling frame of presidents of the American Psychological Association.*

1. Granville Stanley Hall (1892)
2. George Trumbull Ladd (1893)
3. William James (1894)
4. James McKeen Cattell (1895)
5. George Stuart Fullerton (1896)
6. James Mark Baldwin (1897)
7. Hugo Munensterberg (1898)
8. John Dewey (1899)
9. Joseph Jastrow (1900)
10. Josiah Royce (1901)
11. Edmund Clark Sanford (1902)
12. William Lowe Bryan (1903)
13. William James (1904)
14. Mary Whiton Calkins (1905)
15. James Rowland Angell (1906)
16. Henry Rutgers Marshall (1907)
17. George Malcolm Stratton (1908)
18. Charles Hubbard Judd (1909)
19. Walter Bowers Pillsbury (1910)
20. Carl Emil Seashore (1911)
21. Edward Lee Thorndike (1912)
22. Howard Crosby Warren (1913)
23. Robert Sessions Woodworth (1914)
24. John Broadus Watson (1915)
25. Raymond Dodge (1916)
26. Robert Mearns Yerkes (1917)
27. John Wallace Baird (1918)
28. Walter Dill Scott (1919)
29. Shepard Ivory Franz (1920)
30. Margaret Floy Washburn (1921)
31. Knight Dunlap (1922)
32. Lewis Madison Terman (1923)
33. Granville Stanley Hall (1924)
34. Madison Bentley (1925)
35. Harvey A. Carter (1926)
36. Harry Levi Hollingsworth (1927)
37. Edwin Garrigues Boring (1928)
38. Karl Lashley (1929)
39. Herbert Sidney Langfeld (1930)
40. Walther Samuel Hunter (1931)
41. Walter Richard Miles (1932)
42. Luis Leon Thurstone (1933)
43. Joseph Peterson (1934)
44. Albert Theodor Poffenberger (1935)
45. Clark Leonard Hull (1936)
46. Edward Chace Tolman (1937)
47. John Frederick Dashiell (1938)
48. Gordon Willard Allport (1939)
49. Leonard Carmichael (1940)
50. Herbert Woodrow (1941)
51. Calvin Perry Stone (1942)
52. John Edward Anderson (1943)
53. Garder Murphy (1944)
54. Edwin R. Guthrie (1945)
55. Henry E. Garrett (1946)
56. Carl R. Rogers (1947)
57. Donald G. Marquis (1948)
58. Ernest R. Hilgard (1949)
59. Joy Paul Guilford (1950)
60. Robert R. Sears (1951)
61. Joseph McVicker Hunt (1952)
62. Laurence Frederic Shaffer (1953)
63. O. H. Mowrer (1954)
64. E. Lowell Kelly (1955)
65. Theodore M. Newcombe (1956)
66. Lee J. Cronbach (1957)
67. H. F. Harlow (1958)
68. W. Kohler (1959)
69. Donald O. Hebb (1960)
70. Neal E. Miller (1961)
71. Paul E. Meehl (1962)
72. Charles E. Osgood (1963)
73. Quinn McNemar (1964)
74. Jerome Bruner (1965)
75. Nicholas Hobbs (1966)
76. Gardner Lindzey (1967)
77. A. H. Maslow(1968)
78. George A. Miller (1969)
79. George W. Albee (1970)
80. Kenneth B. Clark (1971)
81. Anne Anastasi (1972)
82. Leona E. Tyler (1973)
83. Albert Bandura (1974)
84. Donald T. Campbell (1975)
85. Wilbert J. Mckeachie (1976)
86. Theodore Blau (1977)
87. M. Brewster Smith (1978)
88. Nicholas A. Cummings (1979)
89. Florence L. Denmark (1980)
90. John J. Conger (1981)
91. William Bevan (1982)
92. Max Siegal (1983)
93. Janet T. Spence (1984)
94. Robert Perloff (1985)
95. Logan Wright (1986)
96. Bonnie R. Strickland (1987)
97. Raymond D. Fowler (1988)
98. Joseph D. Matarazzo (1989)
99. Stanley Graham (1990)
100. Charles Spielberger (1991)
101. Jack Wiggins, Jr. (1992)
102. Frank Farley (1993)
103. Ronald E. Fox (1994)
104. Robert J. Resnick (1995)
105. Dorothy W. Cantor (1996)
106. Norman Abeles (1997)
107. Martin E. P. Seligman (1998)
108. Richard M. Suinn (1999)
109. Patrick H. Deleon (2000)
110. Norine G. Johnson (2001)
111. Philip G. Zimbardo (2002)
112. Robert J. Sternberg (2003)
113. Diane F. Halpern (2004)
114. Ronald F. Levant (2005)
115. Gerald P. Koocher (2006)
116. Sharon Stephens Brehm (2007)
117. Alan E. Kazdin (2008)
118. James H. Bray (2009)
119. Carol D. Goodheart (2010)
120. Melba J. T. Vasquez (2011)
121. Suzanne Bennett Johnson (2012)
122. Donald N. Bersoff (2013)

*Year of each president's term is provided in parentheses

population is "Presidents of the APA." This sampling frame also includes an identification number for each population member, starting with 1 (for the first president) and ending with 122 (for the last president). The majority of the people in this sampling frame are no longer alive. Therefore, this population would only be relevant for nonexperimental or historical research. For example, you might have wanted to conduct a descriptive study of the age, gender, and research specialties of past presidents, looking for changes over time (e.g., Hogan, 1994).

Now let's think about another research study. Assume that you work for the APA and the executive director wants you to conduct a telephone survey investigating current APA members' attitudes toward the use and treatment of animals in psychological research. In 2009, there were approximately 150,000 APA members; therefore, the sampling frame would include 150,000 entries. This sampling frame would probably be in a computer file. Next you would randomly select the sample. Perhaps you have enough funds to survey 400 APA members. When you attempt to conduct the telephone survey with the 400 sample members, you will find that not everyone will consent to participate. To indicate the degree of sample participation in research studies, researchers report the response rate. The **response rate** is the percentage of people in the sample selected for study who actually participate. This rate should be as high as possible. If 300 of the 400 members selected in the APA descriptive study sample participate, the response rate would be 75% (i.e., 300 divided by 400).

Response rate
The percentage of people selected to be in a sample who actually participate in the research study

Random Sampling Techniques

The two major types of sampling used in psychological research are random sampling and nonrandom sampling. When the goal is to generalize from a specific sample to a population, random sampling methods are preferred because they produce representative samples. Nonrandom sampling methods generally produce **biased samples** (i.e., samples that are not representative of a known population). Any particular research sample might (or might not) be representative, but your chances are much greater if you use a random sampling method (in particular, if you use an equal probability of selection method). It is especially important that the demographic characteristics of nonrandom samples be described in detail in research reports so that readers can understand the exact characteristics of the research participants. Researchers and readers of reports can then make generalizations based on what the famous research methodologist (and past APA president) Donald Campbell (1916–1996) called **proximal similarity**. Campbell's idea is that you can generalize research results to different people, places, settings, and contexts to the degree that the people in the field are similar to those described in the research study.[1]

Biased sample
A nonrepresentative sample

Proximal similarity
Generalization to people, places, settings, and contexts that are similar to those described in the research study

[1]Campbell (1986) recommended that the term *proximal similarity* be used to replace what he originally called *external validity*. However, the label has never caught on.

Simple Random Sampling

Simple random sampling
A popular and basic equal probability selection method

The most basic type of random sampling is **simple random sampling**. Simple random sampling is the definitive case of an equal probability of selection method. Remember, to be an EPSEM, everyone in the population must have an equal chance of being included in the final sample. It is the characteristic of equal probability that makes simple random sampling produce representative samples from which you can directly generalize from your sample to the population.

One way to visualize simple random sampling is to think of what we call "the hat model." The idea is to write everyone's name on an equal-sized slip of paper. Then put the slips into a hat, cover the top of the hat, and shake it up so that the slips are randomly distributed. Next, pull out a slip of paper, and place it to the side. You would repeat this procedure until the number of selected slips of paper pulled from the hat equals the desired sample size.

When drawing a simple random sample, sampling experts recommend that you use sampling "without replacement" (as we did in the "hat model" example) instead of sampling "with replacement" (where one would put the selected slip of paper back in the hat to potentially be selected again). That's because sampling without replacement is slightly more *efficient* in producing representative samples (i.e., it requires slightly fewer people and is therefore slightly cheaper). When sampling without replacement, you do not allow anyone to be selected more than once; once a person is selected, you do not put the person back into the pool of people to be potentially selected. Perhaps the easiest way to see the need for sampling without replacement is with a very small sample. If you drew a sample of 10 people from a population, you would want all of them to be different people. If you used sampling with replacement and happened to select a person five times, then you would be estimating the characteristics of the population from just 5 people rather than from 10.

In practice, you would not use a "hat model" for drawing a random sample. Before the widespread availability of computers, a traditional way to obtain simple random samples was to use a table of random numbers from which researchers obtained numbers to be used in identifying people to be included in a sample. Today, the use of random number generators is more common. Here are links to some popular and easy-to-use random number generators that are available on the World Wide Web:

http://www.randomizer.org

http://www.psychicscience.org/random.aspx

http://www.random.org

To find additional random number generators, just search the Web for "random number generator."

If you are using a random number generator, such as the ones just listed, you are actually randomly selecting a set of numbers. Therefore, you must make sure that each person in your sampling frame is associated with a number. Look at Figure 5.1, and you will see that each of the APA presidents was assigned an identification number. We will use these numbers to identify the persons selected for our sample.

With the help of the randomizer.org program, we selected a sample of size 10 from our sampling frame in Figure 5.1. We needed 10 numbers randomly selected from 1 to 122 because there are 122 APA presidents in our sampling frame. We went to the Web site and answered each of the questions as follows:

1. How many sets of numbers do you want to generate?
   - We inserted 1 to indicate that we wanted one set of numbers.
2. How many numbers per set?
   - We inserted 10 to indicate that we wanted 10 numbers in our set.
3. Number range?
   - We inserted 1 and 122 to indicate the range of numbers in our sampling frame.
4. Do you wish each number in a set to remain unique?
   - We clicked "yes" to indicate that we wanted sampling *without replacement.*
5. Do you wish to sort the numbers that are generated?
   - Either yes or no is fine. We clicked "yes."
6. How do you wish to view your random numbers?
   - We left the program at its default value ("place markers off") because we did not want a listing of the order in which the numbers were selected.
7. Next, to obtain our set of random numbers we clicked "Randomize Now!"

The resulting set of numbers from the random number generator was 1, 4, 22, 29, 46, 60, 63, 76, 100, and 117. The last step was to go to the sampling frame in Figure 5.1 to determine who from our population was included in the sample. We did this by locating the people in the sampling frame who were associated with our randomly generated identification numbers. Here is the resulting random sample of 10 APA presidents: 1-Granville Stanley Hall, 4-James McKeen Cattell, 22-Howard Crosby Warren, 29-Shepard Ivory Franz, 46-Edward Chace Tolman, 60-Robert R. Sears, 63-O. H. Mower, 76-Gardner Lindzey, 100-Charles Spieberger, and 117-Alan E. Kazdin.

Stratified random sampling
Division of population elements into mutually exclusive groups and then selection of a random sample from each group

Stratified Random Sampling

A second type of random sampling is **stratified random sampling** (or stratified sampling). In stratified sampling, the population is divided into mutually exclusive groups called strata, and then a random sample is selected from each of the groups. The set of groups make up the levels of the **stratification variable**. For example, if gender were the stratification variable, the population sampling frame would be divided into a group of all the females and a group of all the males. Figure 5.2 shows our sampling frame stratified by gender. Stratification variables can be categorical variables (e.g., gender, ethnicity, personality type) or quantitative variables (e.g., intelligence, height, age), and more than one stratification variable can be used.

Stratification variable
The variable on which the population elements are divided for the purpose of stratified sampling

FIGURE 5.2
Sampling frame stratified by gender.*

Female APA Presidents:

1. Mary Whiton Calkins (1905)
2. Margaret Floy Washburn (1921)
3. Anne Anastasi (1972)
4. Leona E. Tyler (1973)
5. Florence L. Denmark (1980)
6. Janet T. Spence (1984)
7. Bonnie R. Strickland (1987)
8. Dorothy W. Cantor (1996)
9. Norine G. Johnson (2001)
10. Diane F. Halpern (2004)
11. Sharon Stephens Brehm (2007)
12. Carol D. Goodheart (2010)
13. Melba J. T. Vasquez (2011)
14. Suzanne Bennett Johnson (2012)

Male APA Presidents:

1. Granville Stanley Hall (1892)
2. George Trumbull Ladd (1893)
3. William James (1894)
4. James McKeen Cattell (1895)
5. George Stuart Fullerton (1896)
6. James Mark Baldwin (1897)
7. Hugo Munensterberg (1898)
8. John Dewey (1899)
9. Joseph Jastrow (1900)
10. Josiah Royce (1901)
11. Edmund Clark Sanford (1902)
12. William Lowe Bryan (1903)
13. William James (1904)
14. James Rowland Angell (1906)
15. Henry Rutgers Marshall (1907)
16. George Malcolm Stratton (1908)
17. Charles Hubbard Judd (1909)
18. Walter Bowers Pillsbury (1910)
19. Carl Emil Seashore (1911)
20. Edward Lee Thorndike (1912)
21. Howard Crosby Warren (1913)
22. Robert Sessions Woodworth (1914)
23. John Broadus Watson (1915)
24. Raymond Dodge (1916)
25. Robert Mearns Yerkes (1917)
26. John Wallace Baird (1918)
27. Walter Dill Scott (1919)
28. Shepard Ivory Franz (1920)
29. Knight Dunlap (1922)
30. Lewis Madison Terman (1923)
31. Granville Stanley Hall (1924)
32. Madison Bentley (1925)
33. Harvey A. Carter (1926)
34. Harry Levi Hollingsworth (1927)
35. Edwin Garrigues Boring (1928)
36. Karl Lashley (1929)
37. Herbert Sidney Langfeld (1930)
38. Walther Samuel Hunter (1931)
39. Walter Richard Miles (1932)
40. Luis Leon Thurstone (1933)
41. Joseph Peterson (1934)
42. Albert Theodor Poffenberger (1935)
43. Clark Leonard Hull (1936)
44. Edward Chace Tolman (1937)
45. John Frederick Dashiell (1938)
46. Gordon Willard Allport (1939)
47. Leonard Carmichael (1940)
48. Herbert Woodrow (1941)
49. Calvin Perry Stone (1942)
50. John Edward Anderson (1943)
51. Garder Murphy (1944)
52. Edwin R. Guthrie (1945)
53. Henry E. Garrett (1946)
54. Carl R. Rogers (1947)
55. Donald G. Marquis (1948)
56. Ernest R. Hilgard (1949)
57. Joy Paul Guilford (1950)
58. Robert R. Sears (1951)
59. Joseph McVicker Hunt (1952)
60. Laurence Frederic Shaffer (1953)
61. O. H. Mowrer (1954)
62. E. Lowell Kelly (1955)
63. Theodore M. Newcombe (1956)
64. Lee J. Cronbach (1957)
65. H. F. Harlow (1958)
66. W. Kohler (1959)
67. Donald O. Hebb (1960)
68. Neal E. Miller (1961)
69. Paul E. Meehl (1962)
70. Charles E. Osgood (1963)
71. Quinn McNemar (1964)
72. Jerome Bruner (1965)
73. Nicholas Hobbs (1966)
74. Gardner Lindzey (1967)
75. A. H. Maslow(1968)
76. George A. Miller (1969)
77. George W. Albee (1970)
78. Kenneth B. Clark (1971)
79. Albert Bandura (1974)
80. Donald T. Campbell (1975)
81. Wilbert J. Mckeachie (1976)
82. Theodore Blau (1977)
83. M. Brewster Smith (1978)
84. Nicholas A. Cummings (1979)
85. John J. Conger (1981)
86. William Bevan (1982)
87. Max Siegal (1983)
88. Robert Perloff (1985)
89. Logan Wright (1986)
90. Raymond D. Fowler (1988)
91. Joseph D. Matarazzo (1989)
92. Stanley Graham (1990)
93. Charles Spielberger (1991)
94. Jack Wiggins, Jr. (1992)
95. Frank Farley (1993)
96. Ronald E. Fox (1994)
97. Robert J. Resnick (1995)
98. Norman Abeles (1997)
99. Martin E. P. Seligman (1998)
100. Richard M. Suinn (1999)
101. Patrick H. Deleon (2000)
102. Philip G. Zimbardo (2002)
103. Robert J. Sternberg (2003)
104. Ronald F. Levant (2005)
105. Gerald P. Koocher (2006)
106. Alan E. Kazdin (2008)
107. James H. Bray (2009)
108. Donald N. Bersoff (2013)

*The 14 female presidents are listed first, followed by the 108 male presidents.