Preface xi

PART I INTRODUCING SPSS 1

Unit 1 Getting Started with SPSS 1

Lesson 1 Starting SPSS 2
Lesson 2 The SPSS Main Menus and Toolbar 5
Lesson 3 Using SPSS Help 13
Lesson 4 A Brief SPSS Tour 18

Unit 2 Creating and Working with Data Files 23

Lesson 5 Defining Variables 24
Lesson 6 Entering and Editing Data 30
Lesson 7 Inserting and Deleting Cases and Variables 36
Lesson 8 Selecting, Copying, Cutting, and Pasting Data 40
Lesson 9 Printing and Exiting an SPSS Data File 45
Lesson 10 Exporting and Importing SPSS Data 48
Lesson 11 Validating SPSS Data 53

Unit 3 Working with Data 58

Lesson 12 Finding Values, Variables, and Cases 59
Lesson 13 Recoding Data and Computing Values 62
Lesson 14 Sorting, Transposing, and Ranking Data 68
Lesson 15 Splitting and Merging Files 72
## Unit 4A Working with SPSS Graphs and Output for Windows 77

- Lesson 16A Creating an SPSS Graph 78
- Lesson 17A Enhancing SPSS Graphs 84
- Lesson 18A Using the Viewer and Pivot Tables 95

## Unit 4B Working with SPSS Charts and Output for the Macintosh 103

- Lesson 16B Creating an SPSS Chart 104
- Lesson 17B Enhancing SPSS Charts 110
- Lesson 18B Using the Viewer 118

## PART II Working with SPSS Procedures 122

### Unit 5 Creating Variables and Computing Descriptive Statistics 122

- Lesson 19 Creating Variables 125
- Lesson 20 Univariate Descriptive Statistics for Qualitative Variables 138
- Lesson 21 Univariate Descriptive Statistics for Quantitative Variables 146

### Unit 6 t Test Procedures 162

- Lesson 22 One-Sample t Test 163
- Lesson 23 Paired-Samples t Test 169
- Lesson 24 Independent-Samples t Test 175

### Unit 7 Univariate and Multivariate Analysis-of-Variance Techniques 182

- Lesson 25 One-Way Analysis of Variance 183
- Lesson 26 Two-Way Analysis of Variance 192
- Lesson 27 One-Way Analysis of Covariance 209
- Lesson 28 One-Way Multivariate Analysis of Variance 222
- Lesson 29 One-Way Repeated-Measures Analysis of Variance 232
- Lesson 30 Two-Way Repeated-Measures Analysis of Variance 242
To determine whether the test was significant, examine the table labeled One-Sample Test. The test is significant, \( t(29) = 2.46, p = .02 \). The \( p \) value is located in the column labeled Sig. Because the \( p \) value is less than .05, we reject the null hypothesis that the population mean is equal to 50 at the .05 level.

### Using SPSS Graphs to Display the Results

Although graphs are sometimes not included in the Results section of a manuscript because of space limitations, graphs should be presented when possible since they convey a rich understanding of the data. Two graphs that can display the data for a one-sample \( t \) test are the histogram and the stem-and-leaf plot. Lesson 21 presents steps for creating both types of graphs. Figure 141 is a histogram showing the distribution of KUDI scores for the 30 cases.

### An APA Results Section

A one-sample \( t \) test was conducted on the KUDI scores to evaluate whether their mean was significantly different from 50, the accepted mean for male adolescents in general. The sample mean of 54.63 (\( SD = 10.33 \)) was significantly different from 50, \( t(29) = 2.46, p = .02 \). The 95% confidence interval for the KUDI mean ranged from 50.78 to 58.49. The effect size \( d \) of .45 indicates a medium effect. Figure 141 shows the distribution of KUDI scores. The results support the conclusion that young male adolescents who do not engage in sports outside of school are somewhat more depressed than average.
Figure 141. Distribution of KUDI scores for adolescent boys who do not participate in sports.

Writing an APA Results Section

Here are guidelines for writing Results sections for statistical methods that require no follow-up procedures, such as the one-sample $t$ test, correlations, the Mann-Whitney $U$ test, or the binomial test.

1. Describe the test, the variables, and the purpose of the test. For example, “A one-sample $t$ test was conducted on the KUDI scores to evaluate whether their mean was significantly different from 50, the accepted mean for male adolescents in general.”

2. Report the results of the statistical test. For example, “With alpha set at .05, the one-sample $t$ test was significantly different from 50, $t(29) = 2.46, p = .02$. The effect size $d$ of .45 indicates a medium effect.”

- Discuss the assumptions of a test if necessary to describe why it was chosen or, more generally, why the test was valid. It is unnecessary to present routinely the assumptions of tests.
- As a rule of thumb, report statistics to two or three decimal places.
- State the alpha level chosen for a statistical test and whether the test is significant or not. The alpha level might be specified for individual tests when reported. Alternatively, the alpha level for all presented statistical tests might be stated in the Methods section or at the beginning of the Results section.
- Report the test value, degrees of freedom, and significance level. When SPSS reports a $p$ value of .000, we should indicate in the Results section that “$p < .01$” or “$p < .001$.”
- Report a confidence interval when possible. A statistical test allows us to make a decision about whether we can or cannot reject a null hypothesis, while a confidence interval allows us to reach the same statistical decision, but also provides an interval estimate of the statistic of interest (e.g., mean, mean difference, or correlation). Confidence intervals should be presented in brackets, unless the range of intervals is described in the working of the text. For example, “The 95% confidence interval for the KUDI mean ranged from 50.78 to 58.49, and therefore the hypothesis that the population KUDI mean is 50 was rejected at the .05 alpha level.” Alternatively, “The 95% confidence interval [50.78, 58.49] indicated the hypothesis that the population KUDI mean is 50 was rejected at the .05 alpha level.”
- Report a statistic that allows the reader to make a judgment about the magnitude of the effect, such as a $d$ statistic for a one-sample $t$ test.
3. Report relevant descriptive statistics, such as the mean and the standard deviation for a one-sample t test.
   - For a simple analysis, the descriptive statistics can be reported in the text as $M = 54.63$, $SD = 10.33$.
   - Statistical notation consisting of Greek letters and abbreviations that are not variables, as well as subscripts and superscripts that are not variables, should be in standard type. Vectors and matrices should be in boldface. All other statistical symbols should be in italics.

4. Summarize the specific conclusions that can be reached on the basis of the analyses, but save interpretation and elaboration on these conclusions for a Discussion section. For example, “The results support the conclusion that male adolescents who do not engage in sports outside of school are somewhat more depressed than the average male adolescent.”

Exercises

The data for Exercises 1 through 4 are in the data set named Lesson 22 Exercise File 1 on the Web at http://www.pearsonhighered.com/greensalkindSPSS. The data are from the following research problem.

John is interested in determining if a new teaching method, the Involvement Technique, is effective in teaching algebra to first graders. John randomly samples six first graders from all first graders within the Lawrence City School System and individually teaches them algebra with the new method. Next, the pupils complete an eight-item algebra test. Each item describes a problem and presents four possible answers to the problem. The scores on each item are 1 or 0 where 1 indicates a correct response, and 0 indicates a wrong response. The SPSS data file contains six cases, each with eight item scores for the algebra test.

1. Compute total scores for the algebra test from the item scores. A one-sample t test will be computed on the total scores.
2. What is the test value for this problem?
3. Conduct a one-sample t test on the total scores. On the output, identify the following:
   a. Mean algebra score
   b. t test value
   c. p value
4. Given the results of the children’s performance on the test, what should John conclude? Write a Results section based on your analyses.

The data for Exercises 5 and 6 are in the data set named Lesson 22 Exercise File 2 on the Web at http://www.pearsonhighered.com/greensalkindSPSS. The data are from the following research problem.

As part of a larger study, Dana collected data from 20 college students on their emotional responses to classical music. Students listened to two 30-second segments from “The Collection from the Best of Classical Music.” After listening to a segment, students rated it on a scale from 1 to 10, with 1 indicating “Makes me very sad” and 10 indicating “Makes me very happy.” Dana computes a total score (hap_sad) for each student by summing the student’s two ratings. Dana conducts a one-sample t test to evaluate whether classical music makes students sad or happy.

5. Conduct the analyses on these data, and write a Results section for it.
6. If you have not presented a graph in your Results section, create a histogram for the hap_sad scores. Label the graph following APA guidelines.
Contents

Preface ......................................................................................... xiii
Acknowledgments ........................................................................ xvii

1. Introduction ............................................................................. 1
   1.1 What Is the Value of Statistics? ............................................ 3
   1.2 Brief Introduction to History of Statistics ......................... 4
   1.3 General Statistical Definitions .......................................... 5
   1.4 Types of Variables ......................................................... 7
   1.5 Scales of Measurement ................................................... 8
   1.6 Summary ........................................................................ 13
   Problems ............................................................................ 14

2. Data Representation ............................................................... 17
   2.1 Tabular Display of Distributions ........................................ 18
   2.2 Graphical Display of Distributions ..................................... 23
   2.3 Percentiles ..................................................................... 29
   2.4 SPSS ............................................................................. 33
   2.5 Templates for Research Questions and APA-Style Paragraph .. 41
   2.6 Summary ...................................................................... 42
   Problems ........................................................................... 43

   3.1 Summation Notation ....................................................... 50
   3.2 Measures of Central Tendency ......................................... 51
   3.3 Measures of Dispersion .................................................. 56
   3.4 SPSS ............................................................................. 65
   3.5 Templates for Research Questions and APA-Style Paragraph .. 69
   3.6 Summary ..................................................................... 70
   Problems ........................................................................... 71

4. Normal Distribution and Standard Scores ................................. 77
   4.1 Normal Distribution ....................................................... 78
   4.2 Standard Scores ............................................................ 84
   4.3 Skewness and Kurtosis Statistics .................................... 87
   4.4 SPSS ........................................................................... 91
   4.5 Templates for Research Questions and APA-Style Paragraph .. 98
   4.6 Summary ..................................................................... 99
   Problems .......................................................................... 99

5. Introduction to Probability and Sample Statistics ....................... 105
   5.1 Brief Introduction to Probability ....................................... 106
   5.2 Sampling and Estimation ............................................... 109
   5.3 Summary ..................................................................... 117
   Appendix: Probability That at Least Two Individuals Have the Same Birthday ..... 117
   Problems .......................................................................... 118

vii
### Contents

6. Introduction to Hypothesis Testing: Inferences About a Single Mean ........................................ 121  
   6.1 Types of Hypotheses ........................................ 122  
   6.2 Types of Decision Errors .................................... 124  
   6.3 Level of Significance ($\alpha$) ................................ 127  
   6.4 Overview of Steps in Decision-Making Process ............. 129  
   6.5 Inferences About $\mu$ When $\sigma$ Is Known .................. 130  
   6.6 Type II Error ($\beta$) and Power ($1 - \beta$) .................. 134  
   6.7 Statistical Versus Practical Significance .................. 138  
   6.8 Inferences About $\mu$ When $\sigma$ Is Unknown ............... 139  
   6.9 SPSS .................................................. 145  
   6.10 G*Power ............................................... 149  
   6.11 Template and APA-Style Write-Up ......................... 155  
   6.12 Summary .............................................. 156  
   Problems ..................................................... 157  

7. Inferences About the Difference Between Two Means .................................................. 163  
   7.1 New Concepts .............................................. 164  
   7.2 Inferences About Two Independent Means ..................... 166  
   7.3 Inferences About Two Dependent Means ....................... 176  
   7.4 SPSS .................................................. 180  
   7.5 G*Power ............................................... 192  
   7.6 Template and APA-Style Write-Up ......................... 195  
   7.7 Summary .............................................. 198  
   Problems ..................................................... 198  

8. Inferences About Proportions ................. 205  
   8.1 Inferences About Proportions Involving Normal Distribution .... 206  
   8.2 Inferences About Proportions Involving Chi-Square Distribution .... 217  
   8.3 SPSS .................................................. 224  
   8.4 G*Power ............................................... 231  
   8.5 Template and APA-Style Write-Up ......................... 234  
   8.6 Summary .............................................. 236  
   Problems ..................................................... 237  

9. Inferences About Variances .............. 241  
   9.1 New Concepts .............................................. 242  
   9.2 Inferences About Single Variance .......................... 244  
   9.3 Inferences About Two Dependent Variances ................... 246  
   9.4 Inferences About Two or More Independent Variances (Homogeneity of Variance Tests) .... 248  
   9.5 SPSS .................................................. 252  
   9.6 Template and APA-Style Write-Up ......................... 253  
   9.7 Summary .............................................. 253  
   Problems ..................................................... 254
10. Bivariate Measures of Association ........................................ 259
   10.1 Scatterplot .................................................................. 260
   10.2 Covariance .................................................................. 263
   10.3 Pearson Product-Moment Correlation Coefficient ......... 265
   10.4 Inferences About Pearson Product-Moment Correlation Coefficient .......... 266
   10.5 Assumptions and Issues Regarding Correlations ............. 269
   10.6 Other Measures of Association ...................................... 272
   10.7 SPSS ......................................................................... 276
   10.8 G*Power ..................................................................... 283
   10.9 Template and APA-Style Write-Up ................................. 286
   10.10 Summary .................................................................... 287
   Problems ............................................................................ 287

   11.1 Characteristics of One-Factor ANOVA Model .................. 292
   11.2 Layout of Data ................................................................ 296
   11.3 ANOVA Theory ............................................................ 296
   11.4 ANOVA Model .............................................................. 302
   11.5 Assumptions and Violation of Assumptions ................. 309
   11.6 Unequal n's or Unbalanced Procedure ......................... 312
   11.7 Alternative ANOVA Procedures ................................. 312
   11.8 SPSS and G*Power ...................................................... 313
   11.9 Template and APA-Style Write-Up ................................. 334
   11.10 Summary .................................................................... 336
   Problems ............................................................................ 336

12. Multiple Comparison Procedures ........................................ 341
   12.1 Concepts of Multiple Comparison Procedures ............... 342
   12.2 Selected Multiple Comparison Procedures .................... 348
   12.3 SPSS ......................................................................... 362
   12.4 Template and APA-Style Write-Up ................................. 366
   12.5 Summary .................................................................... 366
   Problems ............................................................................ 367

   13.1 Two-Factor ANOVA Model ............................................ 372
   13.2 Three-Factor and Higher-Order ANOVA ......................... 390
   13.3 Factorial ANOVA With Unequal n's ............................... 393
   13.4 SPSS and G*Power ...................................................... 395
   13.5 Template and APA-Style Write-Up ................................. 417
   13.6 Summary .................................................................... 419
   Problems ............................................................................ 420

   14.1 Characteristics of the Model .......................................... 428
   14.2 Layout of Data ............................................................. 431
   14.3 ANCOVA Model .......................................................... 431
14.4 ANCOVA Summary Table ........................................ 432
14.5 Partitioning the Sums of Squares ............................... 433
14.6 Adjusted Means and Related Procedures ..................... 434
14.7 Assumptions and Violation of Assumptions .................. 436
14.8 Example .................................................................. 441
14.9 ANCOVA Without Randomization ............................... 443
14.10 More Complex ANCOVA Models ............................... 444
14.11 Nonparametric ANCOVA Procedures ......................... 444
14.12 SPSS and G*Power .................................................. 445
14.13 Template and APA-Style Paragraph ............................ 469
14.14 Summary .............................................................. 471
Problems....................................................................... 471

15. Random- and Mixed-Effects Analysis of Variance Models ........ 477
15.1 One-Factor Random-Effects Model ............................... 478
15.2 Two-Factor Random-Effects Model ............................. 483
15.3 Two-Factor Mixed-Effects Model ................................. 488
15.4 One-Factor Repeated Measures Design ......................... 493
15.5 Two-Factor Split-Plot or Mixed Design .......................... 500
15.6 SPSS and G*Power ................................................... 508
15.7 Template and APA-Style Write-Up .............................. 548
15.8 Summary .............................................................. 551
Problems....................................................................... 551

16. Hierarchical and Randomized Block Analysis of Variance Models .... 557
16.1 Two-Factor Hierarchical Model ................................... 558
16.2 Two-Factor Randomized Block Design for $n = 1$ ............ 566
16.3 Two-Factor Randomized Block Design for $n > 1$ ............. 574
16.4 Friedman Test .......................................................... 574
16.5 Comparison of Various ANOVA Models ..................... 575
16.6 SPSS ................................................................. 576
16.7 Template and APA-Style Write-Up .............................. 603
16.8 Summary .............................................................. 605
Problems....................................................................... 605

17. Simple Linear Regression .......................................... 611
17.1 Concepts of Simple Linear Regression ........................ 612
17.2 Population Simple Linear Regression Model .................. 614
17.3 Sample Simple Linear Regression Model ..................... 615
17.4 SPSS ................................................................. 634
17.5 G*Power ............................................................... 647
17.6 Template and APA-Style Write-Up .............................. 650
17.7 Summary .............................................................. 652
Problems....................................................................... 652
18. Multiple Regression .................................................................................. 657
  18.1 Partial and Semipartial Correlations .............................................. 658
  18.2 Multiple Linear Regression ............................................................... 661
  18.3 Methods of Entering Predictors ....................................................... 676
  18.4 Nonlinear Relationships .................................................................. 679
  18.5 Interactions ....................................................................................... 680
  18.6 Categorical Predictors ...................................................................... 680
  18.7 SPSS .................................................................................................. 682
  18.8 G*Power ............................................................................................ 698
  18.9 Template and APA-Style Write-Up ................................................... 701
  18.10 Summary ......................................................................................... 703
  Problems .................................................................................................. 704

19. Logistic Regression .................................................................................. 709
  19.1 How Logistic Regression Works ..................................................... 710
  19.2 Logistic Regression Equation ......................................................... 711
  19.3 Estimation and Model Fit .................................................................. 715
  19.4 Significance Tests .............................................................................. 716
  19.5 Assumptions and Conditions ............................................................ 721
  19.6 Effect Size .......................................................................................... 725
  19.7 Methods of Predictor Entry ............................................................. 726
  19.8 SPSS .................................................................................................. 727
  19.9 G*Power ............................................................................................ 746
  19.10 Template and APA-Style Write-Up .................................................. 749
  19.11 What Is Next? .................................................................................. 751
  19.12 Summary ........................................................................................ 752
  Problems .................................................................................................. 752

Appendix: Tables ...................................................................................... 757

References .................................................................................................. 783

Odd-Numbered Answers to Problems ...................................................... 793

Author Index .............................................................................................. 809

Subject Index ............................................................................................. 813