
Contents

<i>Introduction</i>	1
PART I	
Statistical Ideas	5
1 Getting Started with SPSS and Using the Computer for Experimental Details	7
1.1 Getting Started with SPSS 7	
1.1.1 Opening a Data File 8	
1.1.2 Entering Your Own Data 9	
1.1.3 Application Activity for Getting Started with SPSS 15	
1.1.4 Importing Data into SPSS 16	
1.1.5 Saving Your Work in SPSS 17	
1.1.6 Application Activity for Importing and Saving Files 18	
1.2 Manipulating Variables 18	
1.2.1 Moving or Deleting Columns or Rows 18	
1.2.2 Combining or Recalculating Variables 20	
1.2.3 Application Activities with Calculations 21	
1.2.4 Recoding Group Boundaries 21	
1.2.5 Application Activities with Recoding 24	
1.2.6 Using Visual Binning to Make Cutpoints for Groups (Advanced Topic) 24	
1.2.7 Excluding Cases from Your Data (Select Cases) 26	
1.2.8 Application Activity for Selecting Cases 27	
1.2.9 Sorting Variables 27	
1.2.10 Application Activities for Manipulating Variables 28	
1.3 Random Number Generation 29	
1.3.1 Generating Random Numbers in Excel 29	
1.4 Summary 30	
2 Some Preliminaries to Understanding Statistics	31

- 2.1 Variables 32
 - 2.1.1 Levels of Measurement of Variables 33
 - 2.1.2 Application Activity: Practice in Identifying Levels of Measurement 35
 - 2.1.3 Dependent and Independent Variables 37
 - 2.1.4 Application Activity: Practice in Identifying Variables 39
 - 2.1.5 Summary of Variables 40
 - 2.1.6 Fixed versus Random Effects (Advanced Topic) 40
- 2.2 Understanding Hidden Assumptions about How Statistical Testing Works 41
 - 2.2.1 Hypothesis Testing 42
 - 2.2.2 Application Activity: Creating Null Hypotheses 43
 - 2.2.3 Who Gets Tested? Populations versus Samples and Inferential Statistics 44
 - 2.2.4 What Does a P-Value Mean? 45
 - 2.2.5 Understanding Statistical Reporting 49
 - 2.2.6 Application Activity: Understanding Statistical Reporting 51
 - 2.2.7 The Inner Workings of Statistical Testing 53
 - 2.2.8 Application Activity: The Inner Workings of Statistical Testing 56
 - 2.2.9 One More Thing I Wish Researchers Would Report—Confidence Intervals 56
 - 2.2.10 Summary of Hidden Assumptions 58
- 2.3 Parametric and Non-Parametric Statistics 58
 - 2.3.1 More about Robust Statistics (Advanced Topic) 59

3 Describing Data Numerically and Graphically and Assessing Assumptions for Parametric Tests

62

- 3.1 Numerical Summaries of Data 62
 - 3.1.1 The Mean, Median, and Mode 63
 - 3.1.2 Standard Deviation, Variance, and Standard Error 65
 - 3.1.3 The Number of Observations and Other Numerical Summaries You Might Want to Report 68
- 3.2 Using SPSS to Get Numerical Summaries 69
 - 3.2.1 Obtaining Numerical Summaries with SPSS and Splitting Groups 70
 - 3.2.2 Application Activities for Numerical Summaries 73
- 3.3 Satisfying Assumptions for Parametric Tests 74
- 3.4 Graphic Summaries of Data: Examining the Shape of Distributions for Normality 75
 - 3.4.1 Histograms 76
 - 3.4.2 Skewness and Kurtosis 78

3.4.3	Stem and Leaf Plots	81
3.4.4	Q-Q Plots	82
3.4.5	Generating Histograms, Stem and Leaf Plots, and Q-Q Plots	82
3.4.6	Application Activity: Looking at Normality Assumptions	86
3.5	Examining the Shape of Distributions: The Assumption of Homogeneity	86
3.5.1	Application Activities for Checking Homogeneity of Variance	88
3.6	Dealing with Departures from Expectations	89
3.6.1	Imputing Missing Data	89
3.6.2	Outliers	91
3.6.3	Transforming Data	92
3.6.4	Application Activities for Transforming Data	94
3.7	Summary	94
4	Changing the Way We Do Statistics: Hypothesis Testing, Power, Effect Size, and Other Misunderstood Issues	96
4.1	Null Hypothesis Significance Tests	97
4.1.1	One-Tailed versus Two-Tailed Tests of Hypotheses	99
4.1.2	Outcomes of Statistical Testing	100
4.1.3	Avoiding Type II Errors	102
4.1.4	Problems with NHST	103
4.2	Power Analysis	104
4.2.1	What Are the Theoretical Implications if Power is Not High?	104
4.2.2	What is the Optimal Level of Power?	105
4.2.3	Examples of Power Analyses	106
4.2.4	Help with Calculating Power Using R	111
4.2.5	Application Activity with Power Calculation	111
4.3	Effect Size	114
4.3.1	Understanding Effect Size Measures	115
4.3.2	Calculating Effect Sizes for Power Analysis	116
4.3.3	Calculating Effect Sizes Summary	117
4.4	Confidence Intervals	121
4.4.1	Application Activity with Confidence Intervals	122
4.5	Summary	124
4.5.1	Power through Replication and Belief in the “Law of Small Numbers”	125

PART II

Statistical Tests	127
5 Choosing a Statistical Test	129
5.1 Statistical Tests that Are Covered in This Book	130
5.2 A Brief Overview of Correlation	131
5.3 A Brief Overview of Partial Correlation	132
5.4 A Brief Overview of Multiple Regression	133
5.5 A Brief Overview of the Chi-Square Test of Independence	135
5.6 A Brief Overview of T-Tests	136
5.6.1 A Brief Overview of the Independent-Samples T-Test	137
5.6.2 A Brief Overview of the Paired-Samples T-Test	138
5.7 A Brief Overview of One-Way ANOVA	139
5.8 A Brief Overview of Factorial ANOVA	141
5.9 A Brief Overview of ANCOVA	143
5.10 A Brief Overview of Repeated-Measures ANOVA	143
5.11 Summary	145
5.12 Application Activity for Choosing a Statistical Test	145
6 Finding Relationships Using Correlation: Age of Learning	148
6.1 Visual Inspection: Scatterplots	149
6.1.1 The Topic of Chapter 6	150
6.2 Creating Scatterplots	150
6.2.1 Adding a Regression Line	152
6.2.2 Viewing Simple Scatterplot Data by Categories	156
6.2.3 Application Activities with Scatterplots	156
6.2.4 Multiple Scatterplots	158
6.3 Assumptions of Parametric Statistics for Correlation	159
6.3.1 Effect Size for Correlation	161
6.4 Calculating Correlation Coefficients	162
6.4.1 Calculating Pearson's r , Spearman's ρ , or Kendall's τ Correlations	163
6.4.2 Application Activities for Correlation	165
6.4.3 Reporting a Correlation	165
6.5 Other Types of Correlations (Advanced Topic)	166
6.5.1 Partial Correlation	166
6.5.2 Calling for a Partial Correlation	167
6.5.3 Reporting Results of Partial Correlation	168
6.5.4 Point-Biserial Correlations and Test Analysis	168
6.5.5 Inter-rater Reliability	170
6.6 Summary	175

7	Looking for Groups of Explanatory Variables through Multiple Regression: Predicting Important Factors in First-Grade Reading	176
7.1	Understanding Regression Design	176
7.1.1	Standard Multiple Regression	179
7.1.2	Sequential (Hierarchical) Regression	180
7.1.3	Data Used in This Chapter	181
7.2	Visualizing Multiple Relationships	181
7.3	Assumptions of Multiple Regression	183
7.3.1	Assumptions about Sample Size	183
7.4	Performing a Multiple Regression	185
7.4.1	Starting the Multiple Regression	187
7.4.2	Regression Output in SPSS	189
7.4.3	Examining Regression Assumptions	195
7.4.4	Reporting the Results of Regression Analysis	197
7.4.5	Application Activity: Multiple Regression	199
7.5	Taking Regression Further: Finding the Best Fit (Advanced Topic)	200
7.6	Summary	204
8	Finding Group Differences with Chi-Square when All Your Variables Are Categorical: The Effects of Interaction Feedback on Question Formation and the Choice of Copular Verb in Spanish	206
8.1	Two Types of Chi-Square Tests	206
8.1.1	Chi-Square for Goodness of Fit	206
8.1.2	Chi-Square for Testing Group Independence	207
8.1.3	Other Situations that May Look like Chi-Square but Are Not	209
8.1.4	Application Activity: Choosing a Test with Categorical Data	215
8.2	Data Inspection: Tables and Crosstabs	216
8.2.1	Summary Tables for Goodness-of-Fit Data	216
8.2.2	Summary Tables for Group-Independence Data (Crosstabs)	217
8.2.3	Application Activities with Tables of Categorical Variables	219
8.3	Visualizing Categorical Data	220
8.3.1	Barplots with One Categorical Variable	220
8.3.2	Barplots with Two Categorical Variables	220
8.3.3	Summary: Barplots in SPSS	222
8.3.4	Application Activities with Barplots	223
8.3.5	Mosaic Plots	223
8.3.6	Doubledecker Plots	225

8.4	Assumptions of Chi-Square	226
8.5	Chi-Square Statistical Test	228
8.5.1	One-Way Goodness-of-Fit Chi-Square in SPSS	228
8.5.2	Two-Way Group-Independence Chi-Square in SPSS	230
8.5.3	Application Activities with Chi-Square in SPSS	234
8.5.4	Testing for Independence in Chi-Square when There Are More than Two Levels in Each Factor (Advanced Topic)	234
8.5.5	Effect Sizes for Chi-Square	237
8.5.6	Reporting Chi-Square Test Results	239
8.6	Summary of Chi-Square	240
9	Looking for Differences between Two Means with T-Tests: Think-Aloud Methodology and Phonological Memory	241
9.1	Types of T-Tests	241
9.1.1	Application Activity: Choosing a T-Test	242
9.2	Data Summaries and Numerical Inspection	243
9.2.1	Visual Inspection: Boxplots	245
9.2.2	Boxplots for an Independent-Samples T-Test (One Dependent Variable Separated by Groups)	246
9.2.3	Boxplots for a Paired-Samples T-Test (a Series of Dependent Variables)	248
9.2.4	Application Activities with Boxplots	250
9.3	Assumptions of T-Tests	250
9.3.1	Adjustments for Multiple T-Tests (Bonferroni, FDR)	251
9.3.2	Data Formatting for Tests of Group Differences (the “Wide Form” and “Long Form”)	252
9.4	The Independent-Samples T-Test	254
9.4.1	Performing an Independent-Samples T-Test	255
9.4.2	Effect Sizes for Independent-Samples T-Tests	258
9.4.3	Application Activities for the Independent-Samples T-Test	259
9.5	The Paired-Samples T-Test	259
9.5.1	Performing a Paired-Samples T-Test in SPSS	260
9.5.2	Effect Sizes for Paired-Samples T-Tests	263
9.5.3	Application Activities with Paired-Samples T-Tests	263
9.6	Reporting T-Test Results	263
9.7	Performing a One-Sample T-Test (Advanced Topics)	264
9.7.1	When to Use a One-Sample T-Test	264
9.7.2	Performing a One-Sample T-Test	265
9.7.3	Application Activities for the One-Sample T-Test	266
9.8	Summary of T-Tests	267

10	Looking for Group Differences with a One-Way Analysis of Variance (ANOVA): Effects of Planning Time	268
10.1	Understanding ANOVA Design	268
10.2	The Topic of Chapter 10	270
10.2.1	Numerical and Visual Inspection of the Data in This Chapter	271
10.3	Assumptions of ANOVA	272
10.4	One-Way ANOVA	274
10.4.1	Omnibus Tests with Post-Hocs or Planned Comparisons	274
10.4.2	Testing for Group Equivalence before an Experimental Procedure	275
10.5	Performing Omnibus One-Way ANOVA Tests in SPSS	275
10.5.1	Calling for a One-Way ANOVA	276
10.5.2	More on Post-Hocs in ANOVA	280
10.5.3	Conducting a One-Way ANOVA Using Planned Comparisons	281
10.5.4	Effect Sizes in One-Way ANOVAs	285
10.5.5	Application Activity with One-Way ANOVAs	286
10.5.6	Reporting the Results of a One-Way ANOVA	287
10.6	Summary of One-Way ANOVAs	288
11	Looking for Group Differences with Factorial Analysis of Variance (ANOVA) when There is More than One Independent Variable: Learning with Music	290
11.1	ANOVA Design	291
11.1.1	ANOVA Design: Interaction	291
11.1.2	Application Activity in Understanding Interaction	292
11.1.3	ANOVA Design of the Obarow (2004) Study	294
11.1.4	ANOVA Design: Variable or Level?	294
11.1.5	Application Activity: Identifying Independent Variables and Levels	295
11.2	Numerical and Visual Inspection	296
11.2.1	Means Plots	298
11.2.2	Creating a Means Plot	298
11.2.3	Changing the Appearance of Graphs in the Chart Editor	299
11.3	Assumptions of Factorial ANOVA	299
11.4	Factorial ANOVAs: Extending Analyses to More than One Independent Variable	300
11.4.1	Making Sure Your Data is in the Correct Format for a Factorial ANOVA	302
11.4.2	Performing a Factorial ANOVA with SPSS	304
11.4.3	Excursus on Type II versus Type III Sums of Squares	

- (Advanced Topic) 311
- 11.4.4 Performing Comparisons in a Factorial ANOVA with SPSS 313
- 11.4.5 Application Activity with Factorial ANOVA 320
- 11.4.6 Calculating Effect Sizes for Factorial ANOVAs 320
- 11.4.7 Reporting the Results of a Factorial ANOVA 321
- 11.5 Summary 322

- 12 Looking for Group Differences when the Same People Are Tested More than Once Using Repeated-Measures ANOVA: Wug Tests and Instruction on French Gender 323**
- 12.1 Understanding Repeated-Measures ANOVA Designs 324
 - 12.1.1 RM ANOVA Design of the Murphy (2004) Study 326
 - 12.1.2 RM ANOVA Design of the Lyster (2004) Study 326
 - 12.1.3 Application Activity: Identifying Between-Groups and Within-Groups Variables to Decide between RM ANOVA and Factorial ANOVA Designs 327
- 12.2 Visualizing Repeated Measures 330
 - 12.2.1 Parallel Coordinate Plots 331
 - 12.2.2 Application Activity with Parallel Coordinate Plots 335
- 12.3 Repeated-Measures ANOVA Assumptions 336
 - 12.3.1 Assumptions of Repeated-Measures ANOVAs 336
 - 12.3.2 Exploring Model Assumptions 336
- 12.4 Performing an RM ANOVA Using SPSS 340
 - 12.4.1 Arranging Data for RM ANOVA 340
 - 12.4.2 Performing the Repeated-Measures ANOVA 341
 - 12.4.3 RM ANOVA Output 343
 - 12.4.4 Exploring Interactions and Main Effects 350
 - 12.4.5 Application Activities with RM ANOVA 354
 - 12.4.6 Reporting the Results of an RM ANOVA 355
- 12.5 Summary 356

- 13 Factoring out Differences with Analysis of Covariance: The Effect of Feedback on French Gender 357**
- 13.1 Visually and Numerically Examining the Data 358
- 13.2 ANCOVA Design 361
 - 13.2.1 Application Activity: Identifying Covariate Designs 361
- 13.3 Assumptions of ANCOVA 364
 - 13.3.1 Checking the Assumptions for the Lyster (2004) Data 365
- 13.4 Performing an ANCOVA 367
 - 13.4.1 ANCOVA Output 367
 - 13.4.2 Application Activities for ANCOVA 370

13.4.3	Reporting the Results of an ANCOVA	371
13.5	Summary	371
14	Statistics when Your Data Do Not Satisfy Parametric Assumptions: Non-Parametric Statistics	373
14.1	Why Use Non-Parametric Statistics?	373
14.2	Non-Parametric Statistics in SPSS	374
14.2.1	Non-Parametric Alternative to the Independent- Samples T-Test (Mann-Whitney Test)	376
14.2.2	Non-Parametric Alternative to the One-Way ANOVA (Kruskal-Wallis)	378
14.2.3	Non-Parametric Alternative to the Paired-Samples T- Test (Wilcoxon Signed Ranks Test or McNemar Test)	381
14.2.4	Non-Parametric Alternative to the One-Way RM ANOVA Test (Friedman Test)	383
14.3	Summary	385
	<i>Appendix</i>	387
	<i>Glossary</i>	389
	<i>References</i>	405
	<i>Author index</i>	413
	<i>Subject index</i>	415