Contents

Preface ix

1. Introduction 1

2. Interactions Between Continuous Predictors in Multiple Regression 9
   - What Interactions Signify in Regression 9
   - Data Set for Numerical Examples 10
   - Probing Significant Interactions in Regression Equations 12
     - *Plotting the Interaction* 12
     - *Post Hoc Probing* 14
     - *Ordinal Versus Disordinal Interactions* 22
     - *Optional Section: The Derivation of Standard Errors of Simple Slopes* 24
   - Summary 27

3. The Effects of Predictor Scaling on Coefficients of Regression Equations 28
   - The Problem of Scale Invariance 28
     - *Linear Regression with no Higher Order Terms* 29
     - *Regression Equations with Higher Order Terms* 30
     - *Simple Slopes of Simple Regression Equations* 31
     - *Ordinal Versus Disordinal Interactions* 31
     - *Numerical Example—Centered Versus Uncentered Data* 32
     - *Should the Criterion Y Be Centered?* 35
     - *Multicollinearity: Essential Versus Nonessential Ill-Conditioning* 35

Interpreting the Regression Coefficients 36
The Interaction Term XZ 36
The First Order Terms X and Z 37
A Geometric Interpretation 39
Standardized Solutions with Multiplicative Terms 40
Appropriate Standardized Solution with Interaction Terms 43
Simple Slope Analysis from the Standardized Solution 44
Relationship Between Raw and "Standardized" Solution 45
Summary 47

4. Testing and Probing Three-Way Interactions 49
Specifying, Testing, and Interpreting Three-Way Interactions 49
Probing Three-Way Interactions 50
Simple Regression Equation 50
Numerical Example 50
Graphing the Three-Way Interaction 52
Testing Simple Slopes for Significance 54
Standard Errors by Computer 54
Crossing Point of Simple Regression Equations with Three-Predictor Interaction 58
Simple Slopes and Their Variances in a Series of Regression Equations 59
Summary 61

5. Structuring Regression Equations to Reflect Higher Order Relationships 62
Structuring and Interpreting Regression Equations Involving Higher Order Relationships 63
Case 1: Curvilinear X Relationship 63
A Progression of More Complex Equations with Curvilinear Relationships 65
Representation of Curvilinearity in ANOVA Versus MR 70
Post Hoc Probing of More Complex Regression Equations 72
Case 1: Curvilinear X Equation 72
The Progression of More Complex Curvilinear Equations Revisited 78
Coefficients of Simple Slopes by Computer 89
Three Final Issues 92
Curvilinearity Versus Interaction 92
What Terms Should Be Included in the Regression Equation? 93
Other Methods of Representing Curvilinearity 95
Summary 97

6. Model and Effect Testing with Higher Order Terms 100
Some Issues in Testing Lower Order Effects in Models Containing Higher Order Terms 100
Question 1. Interpretation of Lower Order Terms When b_3 Is Significant 102
Question 2. Should Lower Order Coefficients Be Tested in Reduced Models When b_3 Is Nonsignificant? 103
Exploring Regression Equations Containing Higher Order Terms with Global Tests 105
Some Global Tests of Models with Higher Order Terms 107
Structuring Regression Equations with Higher Order Terms 110
Sequential Model Revision of Regression Equations Containing Higher Order Terms: Exploratory Tests 111
Application of Sequential Testing Following a Global Test 112
General Application of Sequential Testing 113
Present Approach Versus That Recommended by Cohen (1978) 113
Variable Selection Algorithms 114
Summary 114

7. Interactions Between Categorical and Continuous Variables 116
Coding Categorical Variables 116
Dummy Variable Coding 116
Unweighted Effects Coding 127
Choice of Coding System 129
Centering Revisited 130
Post Hoc Probing of Significant Interactions 130
Testing Simple Slopes Within Groups 131
Computer Procedure 131
Differences Between Regression Lines at a Specific Point 132
Identifying Regions of Significance 134
Summary 137

8. Reliability and Statistical Power 139
Reliability 140
Biased Regression Coefficients with Measurement Error 140
Corrected Estimates of Regression Coefficients in Equations Containing Higher Order Terms 145
Statistical Power 156
Statistical Power Analysis 156
The Effects of Measurement Error on Statistical Power 160
Some Corroborative Evidence: Simulation Studies 165
The Median Split Approach: The Cost of Dichotomization 167
Principal Component Regression Is Not a Cure for Power Woes 168
Coming Full Circle 169
Summary 170

9. Conclusion: Some Contrasts Between ANOVA and MR in Practice 172
Appendix A: Mathematical Underpinnings 177
Appendix B: Algorithm for Identifying Scale-Independent Terms 183
Appendix C: SAS Program for Test of Critical Region(s) 188
References 190
Glossary of Symbols 198
Author Index 204
Subject Index 207
About the Authors 212