Contents

Notes on Contributors ix
Preface xxiii

Multilevel Modeling xxv
Jeffrey, S. Simonoff, New York University, Marc A. Scott, New York University, Brian D. Marx, Louisiana State University

PART I: MULTILEVEL MODEL SPECIFICATION AND INFERENCE 1

1 The Multilevel Model Framework 3
Jeff Gill, Washington University, St. Louis; Andrew J. Womack, University of Florida

2 Multilevel Model Notation—Establishing the Commonalities 21
Marc A. Scott, Patrick E. Shrout, Sharon L. Weinberg, New York University

3 Likelihood Estimation in Multilevel Models 39
Harvey Goldstein, University of Bristol

4 Bayesian Multilevel Models 53
Ludwig Fahrmeir, University of Munich; Thomas Kneib, University of Göttingen; Stefan Lang, University of Innsbruck

5 The Choice Between Fixed and Random Effects 73
Zac Townsend, New York University; Jack Buckley, National Center for Education Statistics & New York University; Masataka Harada, Marc A. Scott, New York University

6 Centering Predictors and Contextual Effects 89
Craig K. Enders, Arizona State University

7 Model Selection for Multilevel Models 109
Russell Steele, McGill University

8 Generalized Linear Mixed Models—Overview 127
Geert Verbeke, Katholieke Universiteit Leuven; Geert Molenberghs, Universiteit Hasselt

9 Longitudinal Data Modeling 141
Nan M. Laird, Harvard University; Garrett M. Fitzmaurice, Harvard University & McLean Hospital

10 Complexities in Error Structures Within Individuals 161
Vicente Núñez-Antón, University of the Basque Country; Dale L. Zimmerman, University of Iowa

11 Design Considerations in Multilevel Studies 183
Gerard van Breukelen, Maastricht University; Mirjam Moerbeek, Utrecht University

12 Multilevel Models and Causal Inference 201
Jennifer Hill, New York University

PART II: VARIATIONS AND EXTENSIONS OF THE MULTILEVEL MODEL 221

13 Multilevel Functional Data Analysis 223
Ciprian M. Crainiceanu, Brian S. Caffo, Johns Hopkins University; Jeffrey S. Morris, University of Texas MD Anderson Cancer Center

14 Nonlinear Models 249
Lang Wu, University of British Columbia; Wei Liu, York University

15 Generalized Linear Mixed Models: Estimation and Inference 271
Charles E. McCulloch, John M. Neuhaus, University of California, San Francisco

16 Categorical Response Data 287
Jeroen Vermunt, Tilburg University

17 Smoothing and Semiparametric Models 299
Jin-Ting Zhang, National University of Singapore

18 Penalized Splines and Multilevel Models 325
Göran Kauermann, University of Munich; Torben Kuhlenkasper, Goethe University Frankfurt

19 Hierarchical Dynamic Models 335
Marina Silva Paez, Dani Gamerman, Federal University of Rio de Janeiro

20 Mixture and Latent Class Models in Longitudinal and Other Settings 357
Ryan P. Browne, Paul D. McNicholas, University of Guelph

21 Multivariate Response Data 371
Helena Geys, Janssen Pharmaceutica & Johnson and Johnson; Christel Faes, Universiteit Hasselt

PART III: PRACTICAL CONSIDERATIONS IN MODEL FIT AND SPECIFICATION 385

22 Robust Methods for Multilevel Analysis 387
Joop Hox, Rens van de Schoot, Utrecht University

23 Missing Data 403
Geert Molenberghs, Universiteit Hasselt; Geert Verbeke, Katholieke Universiteit Leuven

24 Lack of Fit, Graphics, and Multilevel Model Diagnostics 425
Gerda Claeskens, Katholieke Universiteit Leuven

25 Multilevel Models: Is GEE a Robust Alternative in the Presence of Binary Endogenous Regressors? 445
Robert Crouchley, Lancaster University

26 Software for Fitting Multilevel Models 465
Andrzej T. Gałecki and Brady T. West, University of Michigan

PART IV: SELECTED APPLICATIONS 485

27 Meta-Analysis 487
Larry V. Hedges, Northwestern University; Kimberly S. Maier, Michigan State University

28 Modeling Policy Adoption and Impact with Multilevel Methods 503
James E. Monogan III, University of Georgia

29 Multilevel Models in the Social and Behavioral Sciences 521
David Rindskopf, City University of New York Graduate Center

30 Survival Analysis and the Frailty Model 541
Ardo van den Hout, University College London; Brian D.M. Tom, Medical Research Council Biostatistics Unit

31 Point-Referenced Spatial Modeling 559
Andrew O. Finley, Michigan State University; Sudipto Banerjee, University of Minnesota

32 Market Research and Preference Data 581
Adam Sagan, Cracow University of Economics

33 Multilevel Modeling of Social Network and Relational Data 599
Marijtje A.J. van Duijn, University of Groningen

Name Index 619
Subject Index 641