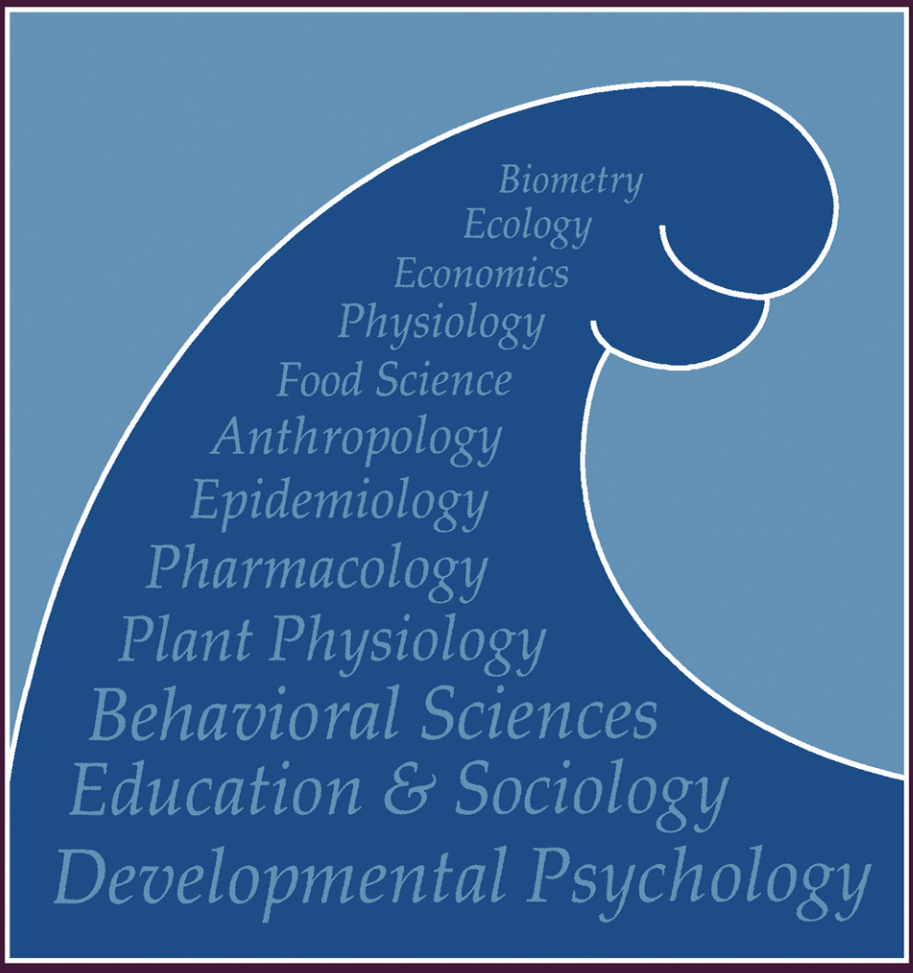
Statistical Methods in Longitudinal Research

Volume II

Time Series and Categorical Longitudinal Data



Edited by

Alexander von Eye

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Edited by

Alexander von Eye

Department of Human Development and Family Studies
The Pennsylvania State University
University Park, Pennsylvania

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Contributors

Numbers in parentheses refer to the pages on which the authors' contributions begin. Numbers in italics indicate contributions to Volume II.

Mark S. Aber (151), *Department of Psychology, The University of Illinois, Champaign, Illinois 61820*

R. Darrell Bock (*289*), *Departments of Education and Behavioral Science, The University of Chicago, Chicago, Illinois 60637*

Jeffrey A. Burr (3), *Department of Sociology, State University of New York at Buffalo, 430 Park Hall, Buffalo, New York 14260*

Clifford C. Clogg (*409*), *Departments of Sociolocy and Statistics, and Population Issues Research Center, The Pennsylvania State University, University Park, Pennsylvania 16802*

Mary Delaney (35), *Department of Human Development and Family Studies, The Pennsylvania State University, University Park, Pennsylvania 16802*

Scott R. Eliason (*409*), *Department of Sociology, The Pennsylvania State University, University Park, Pennsylvania 16802*

Edgar Erdfelder (*471*), *Psychologisches Institut, Universität Bonn, D-5300 Bonn 1, Federal Republic of Germany*

Paul A. Games (81), *Department of Human Development and Family Studies, Pennsylvania State University, University Park, Pennsylvania 16802*

John M. Grego (*409*), *Department of Statistics, University of South Carolina, Columbia, South Carolina 29208*

Randy J. Larsen (*319*), *Department of Psychology, The University of Michigan, Ann Arbor, Michigan 48109–1346*

J. J. McArdle (151), *Department of Psychology, The University of Virginia, Charlottesville, Virginia 22901*

William Meredith (125, *387*), *Department of Psychology, University of California at Berkeley, Berkeley, California 94720*

John R. Nesselroade (3), *Department of Human Development and Family Studies, The Pennsylvania State University, University Park, Pennsylvania 16802*

Trond Petersen (*259*), *Walter A. Haas School of Business, Barrows Hall 350, University of California at Berkeley, Berkeley, California 94720*

David Rindskopf (*443*), *Graduate School and University Center, City University of New York, New York, New York 10036–8099*

Michael J. Rovine (35), *Department of Human Development and Family Studies, The Pennsylvania State University, University Park, Pennsylvania 16802*

Bernhard Schmitz (*351*), *Max-Planck-Institut für Bildungsforschung, Lentzeallee 94, D-1000 Berlin 33, Federal Republic of Germany*

Kathryn A. Szabat (*511*), *Department of Management, LaSalle University, Philadelphia, Pennsylvania 19141*

David Thissen (*289*), *Department of Psychology, University of Kansas, Lawrence, Kansas 66045*

John Tisak (125, *387*), *Department of Psychology, Bowling Green State University, Bowling Green, Ohio, 43402*

Alexander von Eye (*545*), *Department of Human Development and Family Studies, The Pennsylvania State University, University Park, Pennsylvania 16802*

Phillip Wood (225), *Psychology Department, University of Missouri-Columbia, Columbia, Missouri 65211*

Preface

Longitudinal investigations are crucial to the study of development and change. In particular, intraindividual change can be depicted only via repeated observations. To many social scientists, the statistical analysis of repeated measurement data is a challenge because of problems with dependent measures, loss of subjects, availability of computer expertise, or sample size. In many instances, researchers have problems matching substantive questions and statistical methods.

In the methodological literature, considerable progress has been made in the discussion of methods for handling longitudinal data. This progress has remained unnoticed by many, and teaching as well as application of statistical methods has not benefitted from the advances in methodology. In other words, there is a gap between the state of the art of methodology and the application of statistics. It is the main goal of these volumes to narrow this gap.

To illustrate the progress that has been made in the development of statistical methodology, each chapter presents new aspects of methodology or statistics. Here, the attribute "new" applies to all facets of the methods for analysis of longitudinal data. For instance, "new" can mean that methods well-known in certain fields of application are applied to a problem from another field for the first time; it can mean that problems with the application of a software package are identified for the first time; it can mean that a statistical method is further developed to accommodate an extended range of application; it can mean that characteristics of a method are outlined for the first time, so that applicants have a clearer picture of when best to apply this method; it can mean that well-known problems are expressed in terms never used before to express them, so that the researcher has a language available that helps structure problem

specification. All chapters in these volumes contribute something new in this sense. None is merely a write-up of a well-known approach.

A second goal of these volumes concerns the application of the new methods. Reasons for the wide gap between the results obtained in the development of statistical methods and their application in empirical research include the lack of computer software and the lack of instructions on how to use available software in applying new methods. This book emphasizes computational statistics. Each chapter that explicitly discusses statistical methods and their application contains instructions and examples of how to use a particular program or identifies available programs. In addition, a companion book by Rovine and von Eye will be published by Academic Press in which examples of program applications are detailed.

The targeted readership of these books includes students of development and change. The books are not oriented toward a particular discipline. Rather, the scope is broad enough to include researchers from all empirical sciences, including the social sciences, economics, biology, or medicine.

The volumes contain 16 chapters, grouped in four sections. This volume contains Sections 1 and 2, and Volume II contains Sections 3 and 4. The first section covers problems of general interest. It begins with a discussion of change processes (Burr and Nesselroade). Here, central terms are explicated, and general problems are specified. The second chapter discusses the problem of missing data, which is almost ubiquitous in longitudinal research in the social sciences (Rovine and Delaney). Approaches to repeated measurement analysis of variance with covariates are discussed in tandem with problems of the application of commercial software in Chapter 3 (Games).

The second section includes chapters on the structuring of change. It begins with a chapter on longitudinal factor analysis (Tisak and Meredith). This approach has only recently been "redetected," drawing renewed attention from both methodologists and applicants. An approach that has changed the perspectives in the domain of longitudinal research is structural equation modeling. The next chapter covers this approach (McArdle and Aber). Rarely applied in present longitudinal research, but nevertheless promising, are methods of scaling. The chapter by Wood introduces readers to this methodology.

Volume II begins with the third section, which covers the analysis of time series. It opens with a discussion of event history analysis (Petersen), a method that, thus far, has found most application in sociology but

is of great interest to other fields as well. The next chapter treats growth curve analysis (Thissen and Bock), adopting the perspective of mathematical modeling of observed processes. The following chapter, by Larsen, covers spectral analysis. It presents methods of decomposing time series into elementary functions, trigonometric functions in this case. Each of these functions can be interpreted in terms of assumed processes. The fourth chapter in this section discusses time series analysis within the Box and Jenkins framework (Schmitz), including sections on multivariate analysis. The last chapter of this section introduces the reader to methods of segmenting multivariate response curves within the framework of the general linear model (Tisak and Meredith). In recognition of the contribution of Ledyard R Tucker to this methodology, the authors use the term the term "tuckerizing curves."

The fourth section discusses developments in the analysis of repeatedly observed categorical data. It begins with a new approach to formulating longitudinal models for log-linear modeling (Clogg, Eliason, and Grego). The authors adopt the design matrix approach to specifying longitudinal models. Closely related to log-linear modeling is latent class analysis. This approach is covered in the second chapter of this section by Rindskopf, which includes a section on how to use IMSL programs to do parameter estimations. In the third chapter, Erdfelder covers finite mixture distributions. This approach allows one to test assumptions concerning univariate as well as multivariate discrete or continuous distributions. Custom-tailored hypothesis testing in contingency tables can be done with prediction analysis (Szabat), as shown in the fourth chapter, which includes sections describing characteristics of the statistical tests applied to evaluate the model. The final chapter discusses exploratory configural frequency analysis (von Eye). This method allows one to test cellwise whether assumptions concerning longitudinal processes are fulfilled.

I am indebted to a plethora of individuals who supported this work. Viewed from a longitudinal perspective, I would like first to thank J. R. Nesselroade, who encouraged me and helped me to get started. I also would like to thank Academic Press, and in particular Klaus Peters, who was very interested and supportive. Many friends supported this enterprise by reviewing chapters: Constance Jones, Gustav A. Lienert, Jack McArdle, John Nesselroade, Mike Rovine, Holger Wessels, and Phil Wood. I thank them for their efforts and their wisdom. For her invaluable secretarial support, I wish to thank Nancy Cole. I am deeply indebted to the authors who contributed outstanding chapters, often

under adverse conditions: One author's computer exploded while he suffered through the drafting process in Hawaii, but he nevertheless submitted a very impressive paper. All authors responded in a very professional way to requests for revisions. Some authors' patience was tried because other authors needed time to complete their chapters. I thank them all very much. Without their efforts, these volumes would not have been possible. Most of all, I would like to thank Donata, Maxine, Valerie, and Julian, who provide the right context and a longitudinal perspective for mutual development in our family.

Alexander von Eye

III Analysis of Time Series

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Chapter 7

Analyzing Event Histories*

TROND PETERSEN

Walter A. Haas School of Business
University of California, Berkeley
Berkeley, California

Abstract

Event histories are generated by so-called failure time processes and take this form. The dependent variable—for example, some social state—is discrete or continuous. Over time it evolves as follows. For finite periods of time (that is, from one calendar date to another) it stays constant at a given value. At a later date, which is a random variable, the dependent variable jumps to a new value. The process evolves in this manner from the calendar date, when one change occurs, to a later date, when another change occurs. Between the dates of the changes, the dependent variables stays constant.

Data on such processes typically contain information about (a) the date a sample member entered a social state, (b) the date the state later was left, if left, and (c) the value of the next state entered, and so on.

In the analysis of such data the foci are on what determines the amount of time spent in each state and on what determines the value of the next state entered. This chapter describes how one can use continuous-time

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STATISTICAL METHODS IN LONGITUDINAL RESEARCH, VOLUME II: Time Series and Categorical Longitudinal Data