Annotated Bibliography on Research Methods

Prepared for Meeting on

**Assessing the Impact of Childhood Interventions on
Subsequent Drug Abuse**

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Introduction

This document was prepared as a resource for researchers attending the meeting "Assessing the Impact of Childhood Interventions on Subsequent Drug Abuse" organized by the National Institute on Drug Abuse with co-sponsorship by the National Institute of Mental Health. Little is known about how mental health treatments for childhood psychopathologies influence the subsequent risk of drug abuse. This meeting is intended to stimulate the development of research in this important area. In planning for the meeting, NIDA staff and extramural researchers recognized the need to incorporate a systematic consideration of methodological challenges affecting this line of research. This portion of the program will identify resources and strategies for measuring substance abuse and related risk factors and for addressing followup, design, and analysis problems. This document is provided as a supplement to the methodological presentations.

This annotated bibliography samples and documents some of the latest developments in research methods that are relevant to the study of childhood mental health intervention and drug abuse prevention. Our collection covers general topics in research methods, such as research design, sampling strategies and measurement issues, and statistical analysis. It also includes work that specifically addresses methodological concerns that drug abuse prevention researchers often have, such as: the use of self report measures in drug use; issues of selection bias and the use of statistical adjustments in observational studies; selection of covariates; the handling of subject attrition and missing data; and power calculation.

This annotated bibliography emphasizes statistical analyses. This is in response to the increasing need for more sophisticated research designs and analyses in the field of prevention, and also to reflect the recent rapid growth of applied statistical techniques. In addition to traditional analysis that researchers are familiar with, we include techniques that are more recently developed, such as hierarchical linear modeling, growth curve modeling, survival analysis, structural equation modeling and latent transition analysis.

Knowing that the end-users of our work will be researchers who have varying sophistication in methodological training, we try to include work that assumes different levels of statistical understanding. Finally, we want to point out that this bibliography is far from a comprehensive survey of methodological advances. Rather it is compiled to be an introductory guide for prevention researchers, aiming at providing the necessary leads that facilitate researchers' search for useful methodological references.

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I. SAMPLING

A. Basic Sampling Theory and Sampling Designs

1. Cochran, W.G. *Sampling Techniques,* 3rd ed. Toronto: Wiley, 1977.

      The classic text on sampling techniques presents a comprehensive account of sampling theory as it has been developed for use in sample surveys. It contains illustrations to show how the theory is applied in practice, and exercises to be worked by the students. Emphasis was placed on mathematical proofs of sampling theory. A fair amount of mathematical and statistical skills in the readers are presupposed by the author.

2. Hájek, J. *Sampling From a Finite Population*. New York: Marcel Dekker, 1981.

      The monograph presents approaches and results in finite population sampling, along with useful approximations. It is supplemented by theoretical considerations and numerical calculations. The book is divided into three sections. Part I deals with basic concepts, featuring a dialog between the Bayesian and robust approaches. Part II gives a detailed anatomy of methods of sampling and sample correction. Part III evaluates methods of estimation and proposes a general approach to estimation.

3. Hedayat, A.S., & Sinha, B.K. *Design and Inference in Finite Population Sampling*. New York: John Wiley & Sons, 1991.

      The book is an introduction to design and inference in survey sampling for students at the senior or graduate level in statistics. Practitioners of survey sampling would also find the theoretical results in the book useful to their work. It starts with a discussion on probability sampling and inference in finite population sampling, followed by descriptions of various kinds of estimators and sampling designs. The last three chapters of the book deal with special topics in sampling: the superpopulation approach to inference in finite population sampling; randomized response; small area estimation, nonresponse problems and resampling techniques.

4. Kish, L. *Survey Sampling*. New York: John Wiley & Sons, 1965.

      This is a classic text on survey sampling. It is written for social scientists who need to conduct surveys. The book provides a working knowledge of practical sampling methods. Necessary working formulas and underlying assumptions are given. Readers will also find a variety of examples, with computations laid out in detail. The book consists of three parts. Part 1 deals with the fundamentals of survey sampling, such as basic sampling theory and some commonly used designs. Part 2 discusses special problems and techniques in survey sampling. The author discusses issues like area sampling, multistage sampling and sampling from imperfect frames. Part 3 discusses biases and nonsampling errors, as well as some issues of inference from survey data.

5. Krishnaiah, P.R., & Rao, C.R. *Handbook of Statistics, Vol. 6* (*Sampling*). Amsterdam: Elsevier Science Publishers, 1988.

      The volume is devoted to the theory and practice of sample surveys. Various authors contributed chapters on the following special topics: Historical account of random sampling methods; overview of survey sampling; optimality of sampling strategies; cost-efficiency of simple random sampling; role of randomization in inference; systematic sampling; repeated sampling over time; theoretical aspects of

inference in finite population; interpenetrating subsamples; analysis of contingency tables compiled from survey data; various methods of variance estimation in sample surveys; methodology of ratio and regression estimation; special survey techniques in environmental and ecological studies; sampling methods in marketing research; methods for controlling and estimating observational errors in sample surveys; new problems in the design of sample surveys.

6. Levy, P.S., & Lemeshow, S. *Sampling of Populations: Methods and Applications*. New York: John Wiley & Sons, 1999.

As with earlier editions, this edition was written for the practicing statistician and for researchers who work with complex sample survey data. Thus, important formulas are highlighted and the procedures for drawing a sample are presented step-by-step. Because of its emphasis on self-learning, the book remains an excellent choice for individuals who want to learn how to analyze complex sample survey data and who find heuristic demonstrations and small hand-worked examples to be informative. The authors also illustrate how one can use SUDAAN and STATA to obtain estimates and standard errors for various sampling designs.

7. Levy, P.S., & Lemeshow, S. *Sampling for Health Professionals*. Belmont, CA: Lifetime Learning Publications, 1980.

The book is designed as a reference for the working statistician. It is also a primary text for a course in sample survey methods that emphasizes applications rather than theory. The book covers basic sampling theory and have chapters describing various sampling designs, such as systematic sampling and two-stage cluster sampling. For each type of sampling designs, the author describes how to set up the design, estimation of population parameters, sampling distribution of estimates. It also discusses costs, feasibility, statistical problems, and measurement problems in connection with a proposed sample survey.

8. Kasprzyk, D., Duncan, G.J., Kalton, G., & Singh, M.P. *Panel Surveys*. New York: John Wiley & Sons, 1989.

This volume contains 22 invited papers presented at the symposium "The International Symposium on Panel Surveys" held in 1986. The book is organized into the following sections: (1) Issues in the Design of Panel Surveys; (2) Collection and Design Issues; (3) Statistical Design and Estimation; (4) Database Management; (5) Sources of Nonsampling Error; (6) Panel Conditioning; (7) Estimation of Cross-Sectional and Change Parameters; and (8) Modeling Consideration. Further, the chapters within each section are of three types—providing a general review of a topic related to panel surveys, presenting results related to methodological issues common to panel surveys, or presenting current research on panel survey problems.

9. Skinner, C.J., Holt, D., & Smith, T.M.F., eds. *Analysis of Complex Surveys*. New York: Wiley, 1989.

The edited book resulted from two research programs on "The Analysis of Data from Complex Surveys" held in the United Kingdom between 1977 and 1985 and the conference was attended by a number of international researchers with expertise in complex surveys. The book was divided into three parts: (1) aggregated analysis—standard errors and significance tests; (2) aggregated analysis—point estimation and bias; and (3) disaggregated analysis—modeling structured populations. The author pointed out that "typical readers" of the book would be researchers who wishes to apply statistical methods to survey data and who are familiar with those methods to the level of Bishop et al. (1975), for

contingency table analysis, or Draper and Smith (1981) for regression analysis. A background in survey sampling to the level of a text such as Cochran (1977) is also assumed.

B. Sampling Members from Rare Populations

10. Thompson, S.K. *Sampling*, New York: John Wiley & Sons, 1992.

The book covers the basic and standard sampling design and estimation methods and, in addition, gives special attention to methods for populations that are inherently difficult to sample, elusive, rare, clustered, or hard to detect. It is intended as a reference for scientific researchers and others who use sampling and as a textbook for a graduate or upper-level undergraduate course in sampling.

II. MEASUREMENT

A. Measurement Theories and Procedures

11. Embretson, S.E., & Hershberger, S.L. *The New Rules of Measurement: What Every Psychologist and Educator Should Know*. Mahwah, NJ: Lawrence Erlbaum Associates, 1999.

This volume brings together leading measurement researchers and practitioners to discuss new developments in test development, administration, scoring, and interpretation. With topics ranging from intelligence testing and personality assessment to validity issues in testing theory and practice, psychometricians and clinical and educational measurement specialists alike will find this book a useful tool.

12. Fuller, W.A. *Measurement Error Models*. New York: John Wiley & Sons, 1987.

This volume addresses the issue of response error with a book-length treatment of the theory and applications. It aims to promote the use of statistical techniques that explicitly recognize the presence of measurement error. The book begins with an introduction to techniques for simple models, such as measurement variance known, instrumental variable estimation, factor analysis, and others. Subsequent chapters examine, in detail, vector explanatory variables, extensions of the single relation model, and multivariate models.

13. McLellan, A.T. Measurement issues in the evaluation of experimental treatment intervention. In: Kilbey, M.M., & Asghar, K., eds. *Methodological Issues in Epidemiological, Prevention, and Treatment Research on Drug-Exposed Women and Their Children. National Institute on Drug Abuse Research Monograph 117*. DHHS Pub. No. (ADM)92-1881. Washington, DC: Supt. of Docs., U.S. Govt. Print. Off., 1992, pp. 18-30.

The chapter focuses on issues of patient and treatment measurement that would be encountered in an evaluation of an experimental treatment or a novel therapeutic program. The first part of the chapter deals with the rationale and methods associated with collecting patient information at the start of a treatment intervention; the middle part deals with the measurement of the intervention; and the last part deals with the rationale for and the methodological issues in measuring patient outcome following an intervention.

14. Wilson, M. *Objective Measurement: Theory into Practice*. Norwood, NJ: Ablex Publishing, 1992.

  The chapters in this volume were selected from papers presented at the Fifth International Objective Measurement Workshop, held at UC Berkeley in 1989. The papers are grouped into three themes: 1. Measurement practice: how objective measurement methods are applied to a variety of fields; 2. Measurement theory: development of new measurement models that extend objective measurement into new domains; and 3. Mathematical and statistical applications to measurement: mathematical programming techniques, parameter estimation, and generalizability theory.

B. Reliability and Validity

15. Harrison, L., & Hughes, A., eds. *The Validity of Self-Reported Drug Use: Improving the Accuracy of Survey Estimates. National Institute on Drug Abuse Research Monograph 167*. NIH Pub. No. (ADM)97-4147. Washington, DC: Supt. of Docs., U.S. Govt. Print. Off., 1997.

  The monograph arises from a technical review that was conducted on September 8 and 9, 1994, in Gaithersburg, MD, where papers were presented by 25 leading U.S. researchers on various aspects pertaining to the validity of self-reported drug use. It reviews a number of studies that use some presumably more accurate measure of drug use to validate self-reported use. In addition, evolving methods to improve a wide variety of procedures used in survey designs are explored, including computer-assisted interviewing, predictors of response propensity, measurement error models, and improved prevalence estimation techniques. Experimental manipulations of various survey conditions and situational factors also show promise in improving the validity of drug prevalence estimates in self-report surveys.

16. Marsh, H.W., & Bailey, M. Confirmatory factor analyses of multitrait-multimethod data: A comparison of alternative models. *Appl Psychol Meas* 15:47-70, 1991.

  The paper briefly describes the use of the CFA approach in analyzing MTMM data and the inherent problems in such an approach. The authors then present results of two studies, one with real data and one with simulated data, that were set up to evaluate the performance of the CFA methods for analyzing different types of MTMM data. The correlated uniqueness model converges most of the time but the general model only converges about one quarter of the time. The authors then presents their recommendations for using the CFA approach in dealing with MTMM problem

17. Traub, R.E. *Reliability for Social Sciences: Theory and Application*. Thousand Oaks, CA: Sage Publications, 1994.

  The author provides a careful and illustrative review of the principles of classical reliability theory. He also explores some general strategies for improving measurement procedures. The book begins with a presentation of random variables and the expected values of a random variable. It then covers topics like the definition of reliability as a coefficient and possible uses of a coefficient, the notion of parallel tests so as to make possible the estimation of a reliability coefficient for a set of measurements, what to do when parallel tests are not available, what factors affect the reliability coefficient, and how to estimate the standard error of measurement.

18. Zimmerman, D.W., & Williams, R.H. Note on the reliability of experimental measures and the power of significance tests. *Psychol Bull* 100:123-124, 1986.

   The paper deals with the paradox that the power of a statistical test sometimes increases and sometimes decreases as the reliability coefficient of a dependent variable increases. The author point out the relation between statistical power and the reliability coefficient is not a functional relation unless another variable—either true variance or error variance—remain constant.

C. Special Topics in Measurement

19. Shavelson, R.J., & Webb, N.M. *Generalizability Theory: A Primer*. Newbury Park, CA: Sage Publications, 1991.

   The book offers an intuitive development of generalizability theory, a technique for estimating the relative magnitudes of various components of error variation and for indicating the most efficient strategy for achieving desired measurement precision. The text covers a variety of topics such as generalizability studies with nested facets and with fixed facets, measurement error and generalizability coefficients, and decision studies with same and with different designs.

20. Hambleton, R.K., Swaminathan, H., & Rogers, H.J. *Fundamentals of Item Response Theory*. Newbury Park, CA: Sage Publications, 1991.

   The book provides a lucid but rigorous introduction to the fundamental concepts of item response theory, followed by thorough, accessible descriptions of the application of IRT methods to problems in test construction, identification of potential biased test items, test equating, and computerized-adaptive testing. A summary of new directions in IRT research and development completes the book.

21. Camilli, G., & Shepard, L.A. *Methods for Identifying Biased Test Items*. Thousand Oaks, CA: Sage Publications, 1994.

   Aimed at helping researchers understand how item bias methods work, this book provides practical advice and specific details on the most useful methods for particular testing situations. Beginning with a review of early bias methods and the fairness issues associated with the topic of test bias, the authors explain the logic of each method in terms of how differential item functioning (DIF) is defined by the method–and how well the method can be expected to work in various situations. In addition, chapters include a summary of findings regarding the behavior of the various indices in empirical studies, especially their reliability, correlation with known bias criteria, and correlations with other bias methods. The book concludes with a set of principles for deciding when DIF should be interpreted as evidence of bias.

III. STUDY DESIGN

A. General References in Research Design and Data Analysis

22. Ager, J.W. Discussion: Statistical analysis in treatment and prevention program evaluation. In: Kilbey, M.M., & Asghar, K., eds. *Methodological Issues in Epidemiological, Prevention, and Treatment Research on Drug-Exposed Women and Their Children. National Institute on Drug Abuse Research Monograph 117*. DHHS Pub. No. (ADM)92-1881. Washington, DC: Supt. of Docs., U.S. Govt. Print. Off., 1992, pp. 31-40.

The chapter focuses on problems of statistical analysis in the context of evaluations of substance abuse treatment and prevention programs. The statistical and design issues discussed includes the following: (1) types of designs and their associated statistical analyses; (2) covariance and other adjustment techniques in analyses of quasi-experimental design data; (3) modeling change; and (4) meta-analysis.

23. Anderson, V.L., & McLean, R.A. *Design of Experiments: A Realistic Approach*. New York: Marcel Dekker, Inc., 1974.

This book on design of experiments is arranged so that the reader may go from the simple to the complex designs and grasp the appropriate analyses from the resulting data. Chapters 1 to 3 cover basic concepts in experimental designs. Chapters 4 through 7 cover various experimental designs and illustrate the usage of restriction error concept. Chapter 8 expresses a view on Latin square type designs, and chapters 9 and 10 provide descriptions on the 2n completely randomized factorials. Chapters 11 and 12 deal with three-level factorial experiments, mixed factorial experiments, and incomplete block designs. The last chapter of the book describes response surface exploration.

24. Bryant, K.J., Windle, M., & West, S.G., eds. *The Science of Prevention: Methodological Advances from Alcohol and Substance Abuse Research*. Washington, DC: American Psychological Association, 1997.

The volume describes latest developments of methodological methods in the field of substance abuse research. Most of the contributors to the book are active researchers in the field of substance abuse prevention who are also methodological experts. It aims at promoting critical thinking among new and established investigators about how to design research and analyze research findings. Although the substantive focus of many chapters is on applications to the prevention of alcohol and substance abuse, nearly all of the methodological principles and statistical models are general and have potential application to the full range of areas in which prevention research takes place.

25. Collins, L.M., & Millsap, R. *Innovative methods for prevention research. Special issue of Multivariate Behavioral Research*. Mahwah, NJ: Erlbaum, 1998.

The special issue includes six examples of innovative methodlogical procedure useful in prevention research. Hedeker and Mermelstein present a model for multilevel logistic regression with ordinal outcomes. Reboussin et al. discuss a method for including continuous predictors in latent transition models. Boker and Graham provides a conceptual introduction to dynamical systems analysis. Sayer and Willet describes cross-domain analysis in latent growth curve analysis. Schafer and Olsen present the technique of multiple imputation and its use to solve missing data problems. Bacik et al. discuss a type of missing data that is common in prevention research: the participant who is absent for one data collection occasion and then returns to the study. They explore the researcher's options in performing survival analysis on this kind of data.

26. Coursey, R.D., ed. *Program Evaluation for Mental Health: Methods, Strategies, Participants*. New York: Grune & Stratton, Inc., 1977.

The book focuses on setting up and running evaluation programs for real-life mental health delivery systems. It summarizes literature and provides both broad conceptualizations about the structure of evaluation activity as well as practical knowledge. The book emphasizes the human dimensions of

evaluation, such as staff's need for economic survival and esteem. It also emphasize the role of program evaluation in staff education and development. The author also take the perspective that program evaluation is one component of the overall process of program development and program planning. The book is divided into four sections: (1) methods and techniques of evaluation, (2) strategies for implementing those methods, (3) the participants in program evaluation, and (4) resources available to mental health workers.

27. Daniel, W.W. *Biostatistics: A Foundation for Analysis in the Health Sciences,* 7th ed. New York: John Wiley & Sons, 1999.

The text is written for health professionals in need of a reference book on statistical methodology. It covers basic concepts in statistics such as probability, sampling distribution, estimation and hypothesis testing. It describes common statistical techniques such as analysis of variance, simple and multiple regression, logistic regression, chi-square test and nonparametric and distribution-free statistics.

28. Dowdy, S., & Wearden, S. *Statistics for Research*. New York: Wiley, 1983.

This is an introductory textbook to statistics and it is intended for students who have no prior background in statistical methods. The author try to provide both an understanding of the concepts of statistical inference as well as the methodology for the most commonly used analytical procedures. The book covers basic concepts in statistics, such as probability distributions, sampling distribution of averages and paired variables. It then describes commonly used statistical techniques, such as ANOVA, ANCOVA, and multiple regression.

29. Flay, B.R., & Petraitis, J. Methodological issues in drug use prevention research: Theoretical foundations. In: Leukefeld, C.G., & Bukoski, W.J., eds. *Drug Abuse Prevention Intervention Research: Methodological Issues. NIDA Research Monograph 107*. DHHS Pub. No. (ADM) 91-1761. Washington, DC: Supt. of Docs., U.S. Govt. Print. Off., 1991. pp. 81-109.

The chapter discusses the theoretical foundation of drug use prevention program development and research. The authors reviewed theories of drug use onset and behavior change and then focus on the functions and roles of theory and their methodological applications. Issues like implementation quality, external validity, construct validity, and special method—theory relationships are discussed in later parts of the chapter.

30. Jason, L., Thompson, D., & Rose, T. Methodological issues in prevention. In: Edelstein, B., & Michelson, L., eds. *Handbook of Prevention*. New York: Plenum Press, 1986, pp. 1-19.

The chapter reviews methodological issues that need to be considered in designing and implementing preventive-oriented interventions. The authors first review theoretical notions underlying preventive programs. Then they discuss specific methodological issues like goal selection, assessment and screening, experimental and quasi-experimental designs, generalization and maintenance, cost-benefit analyses, meta-analyses, social validation, and monitoring the integrity of preventive interventions. The final section summarizes some of the obstacles to designing well-planned preventive interventions, and speculates on the types of new directions.

31. Judd, C.G., & Kenny, D.A. *Estimating the Effects of Social Intervention*. Cambridge: Cambridge University Press, 1981.

The authors present a discussion of the various research designs used to evaluate social interventions. Designs described in the book include randomized experiments, regression discontinuity design, nonequivalent control group design, interrupted time-series design, post-only correlational design. Judd and Kenny describe each design and the usual statistical analysis procedures to analyze the design. They then discuss possible complications in the analysis and suggest practical solutions to the complications.

32. Maxwell, S.H., & Delaney, H.D. *Designing Experiments and Analyzing Data: A Model Comparison Perspective*. Belmont, CA: Wadsworth, 1990.

The book is written to serve as either a textbook or a reference book on the topic of designing experiments and analyzing experimental data. The authors proposed a model comparison approach, which allows the use of a few basic formulas that can be applied to every experimental design. Such an approach also allows for further extension to more complex data-analytic methodologies such as structural equation modeling. Part I of the book explains the logic of experimental design and the role of randomization in behavioral research. Part II deals with model comparison for between-subject designs, starting with a discussion of the general linear model. Part III discusses model comparisons for designs involving within-subject factors. Part IV covers alternative analysis strategies such as robust ANOVA and ANCOVA, repeated measures designs.

33. Montgomery, D.C. *Design and Analysis of Experiments,* 3rd ed. New York: John Wiley & Sons, 1991.

This is an introductory textbook dealing with the design and analysis of experiments. The book is intended for readers who have some background in elementary statistics and some familiarity with matrix algebra is required in portions of chapters 15 and 16. The third edition is a major revision of the book. While maintaining a balance between design and analysis topics, new materials and examples are added. The reorganization of the material on factorial and fractional factorial designs in chapters 9, 10, and 11 provide more in-depth treatment of these topics. Chapter 12 covers the Taguchi approach to parameter design along with a critique of the method. Chapter 16 describes response surface design and introduce the reader to the mixture problem.

34. Rose, J.S., Chassin, L., Presson, C.C., & Sherman, S.J. *Multivariate Applications in Substance Use Research: New Methods for New Questions*. Mahwah, NJ: Lawrence Erlbaum Associates, 2000.

This edited volume introduces the latest advances in quantitative methods and illustrates ways to apply these methods to important questions in substance use research. Reflecting current research trends, the book examines the use of longitudinal techniques to measure processes of change over time. Researchers faced with the task of studying the causes, course, treatment, and prevention of substance use and abuse will find this volume helpful for applying these techniques to make optimal use of their data.

B. Different Types of Study Designs

1. Case Studies

35. Bromley, D.B. *The Case-Study Method in Psychology and Related Disciplines.* Chichester: John Wiley & Sons, 1986.

   This book deals with both theory and practice of individual case-studies. It describes in detail how to conduct psychological case-studies, how to evaluate them, and how to use diagrams and decision analysis in case-studies.

36. Gottman, J.M. N-of-one and N-of-two research in psychotherapy. *Psychol Bull* 80:93-105, 1973.

   Gottman's paper suggests that time-series methods are useful in N-of-one research and we can use it to draw weak and strong causal inferences. The author discusses the use of the method in process research, outcome research, and measurement design. The paper also pay special attention to the use of interrupted time series designs. According to the author, time-series designs have the following advantage: (1) It permits the study of the single subject and the use of subject-as-his-own-control research; (2) It allows the study of the form of the effect of the intervention over time; and (3) It allows one to use information over time as feedback for making decisions.

37. Hersen, M., & Barlow, D. *Single Case Experimental Designs: Strategies for Studying Behavior Change*. New York: Pergamon Press, 1976.

   The book discusses general issues in single-case approach, such as behavior trends and intrasubject averaging and the problem of generality of findings. It also describes general procedures in such research. The authors then write about different types of single-case designs. Topics covered include basic A-B-A withdrawal designs and their extensions, multiple baseline designs, alternative treatment design. The last two chapters of the book introduce readers to some appropriate statistical analyses that can be used to analyse data from single-case designs and various ways to replicate findings from these experiments.

38. Hoyle, R.H. *Statistical Strategies for Small Sample Research*. Thousand Oaks, CA: Sage Publications, 1999.

   The book describes and illustrates statistical strategies that are appropriate for analyzing data from small samples of fewer than 150 cases. It covers such topics as the use of multiple imputation software to deal with missing data in small data sets; ways to increase power when sample size cannot be increased; strategies for computing effect sizes and combining effect sizes across studies; how to hypothesis test using bootstrapping; methods for pooling effect size indicators from single-case studies; frameworks for drawing inferences from cross-tabulated data; how to determine whether a correlation or covariance matrix warrants structure analysis; under which conditions latent variable modeling is a viable approach to correct for unreliability in the mediator; the use of dynamic factor analysis to model temporal processes by analyzing multivariate, time-series data; techniques for coping with estimation problems in confirmatory factor analysis in small samples; how the state space model can be used with small samples; and the use of partial least squares as an alternative to SEM when n is small and/or the number of variables in a model is large.

39. Kratochwill, T.R., & Levin, J.R. *Single-Case Research Design and Analysis: New Directions for Psychology and Education*., Hillsdale, NJ: Lawrence Erlbaum Associates, Publishers, 1992.

The book summarizes the latest development in the field of single-case research design and analysis. The edited volume consists of contributions from researchers from various fields who utilize or analyze data from such designs. The introductory and overview chapter of the book also have a list of past textbooks that covered the topic of single subject research design.

40. Richards, S.B., Taylor, R.L., Ramasamy, R., & Richards, R.Y. *Single Subject Research: Applications in Educational and Clinical Settings*. San Diego: Singular Publishing Group, Inc., 1999.

The textbook provides background knowledge, basic concepts, and understanding of relevant issues related to applied behavior analysis and specifically to single subject research designs. It presents summaries of the use of the designs and it outlines the major features of such procedures. It also provides a review of the single subject research literature as well as descriptions on how to actually implement these designs. The designs that are covered includes withdrawal designs, multiple baseline designs, alternative treatment designs. The last chapter in the book also touched on the various kinds of analyses that are useful for analyzing single subject design data.

2. Observational Studies

41. Ahlbom, A. *Biostatistics for Epidemiologists*. Boca Raton: Lewis Publishers, 1993.

The author presents biostatistical methods used in the analysis of epidemiological studies. It examines the theoretical background of the methods described and discussed general principles that apply to the analysis of epidemiological data. Specific topics addressed include statistical interference in epidemiological research, important methods used for analyzing epidemiological data, multivariate models, dose-response analysis, analysis of the interaction between causes of disease, meta-analysis, and computer programs.

42. Anderson, S., Auquier, A., Hauck, W.W., Oakes, D., Vandaele, W., & Weisberg, H.I. *Statistical Methods for Comparative Studies*: *Techniques for Bias Reduction*. New York: John Wiley & Sons, 1980.

Anderson et al. present various techniques for the design and analysis of comparative studies, which are often used when randomization is not feasible. The book covered main conceptual issues in the design and analysis of comparative studies and possible bias incurred. The book provide concise and useful discussion of the techniques of matching, standardization and stratification, analysis of covariance, logit analysis and log-linear analysis, survival analysis. The later part of the book discuss the comparative effectiveness of the techniques in reducing bias and other practical issues that must be faced before drawing causal inferences from comparative studies.

43. Clayton, D., & Hills, M. *Statistical Models in Epidemiology*. Oxford: Oxford University Press, 1993.

The book is intended for students enrolled for a masters degree in epidemiology, clinical epidemiology, or biostatistics. In showing how to use probability models in epidemiology the authors have chosen to emphasize the role of likelihood. Such an approach to statistics is both simple and intuitively satisfying, and has the additional advantage that it requires the model and its parameters to be made explicit, even in the simplest situations. More complex problems can then be tackled by natural

extensions of simple methods and do not require a whole new way of looking at things. The book also covers in depth topics in regression models.

44. Elwood, J.M. *Causal Relationships in Medicine: A Practical System for Critical Appraisal*. Oxford: Oxford University Press, 1988.

The book focuses on issues related to etiological research, early diagnosis and screening, randomized and non-randomized clinical trials, prognostic studies, health service issues, and the evaluation of health education and promotion. The book start with a discussion of the concept of causation, and then the author discuss the types of study design that can be used to demonstrate causation and the way in which their key results can be expressed precisely and simply. Chapters 4 to 8 deal with issues pertaining to subject selection, observation bias, confounding, and chance variation and various forms of validity. Chapters 9, 10, and 11 give examples of the application of the scheme to three study designs: cohort study, case-control study, and randomized clinical trial.

45. Feinstein, A.R. *Clinical Epidemiology: The Architecture of Clinical Research*. Philadelphia: W.B. Saunders Co., 1985.

The content of this book can act as a "primer" for non-clinical readers, and it explains the scientific approach used by clinical investigators to quantitative challenges in group data of diagnosis, prognosis, therapy, etiology, and other medical topics. The text also cover topics and methods that are not included in text of public health epidemiology. The first six chapters provide an outlined overview of the field. The next four chapters deal with statistics. Chapters 11 to 17 offer a single standard and model for studies of cause-effect relationships in both therapeutic agents and etiologic agents. Chapters 18 to 24 concern nonrandomized designs, such as various forms of case-control studies. Chapters 25 to 27 are devoted to process evaluation. The last three chapters contain some special topics: the definition of "normal"; the contribution and limitation of randomized trials and outline of other types of epidemiology not mentioned in other parts of the book.

46. Friedman, G.D. *Primer of Epidemiology*. New York: McGraw-Hill Inc., 1994.

The book was originally written to be a brief, simple, clear introduction to epidemiology for health care professionals. In subsequent editions of the book, there were elaboration and updating of some methodological concepts and factual information, as well as problems to be solved in areas in epidemiology. In this fourth edition, some new concepts and methods were introduced: the proportional mortality rate and its use in occupational studies, the coefficient of variation, the kappa coefficient and intra-class correlation coefficient, open versus closed cohorts, Kaplan-Meier survival analysis, quality-adjusted life years (QALYs), some principles concerning confounding variables, Poisson regression, receiver operating characteristic (ROC) curves. The chapter on case-control studies was considerably revised in this new edition too.

47. Kahn, H.A., & Sempos, C.T. *Statistical Methods in Epidemiology*. New York: Oxford University Press, 1989.

This book is a major revision of H.A. Kahn's *An Introduction to Epidemiologic Methods*, which is meant to be a book about statistical methods for chronic disease epidemiology that could be read and understood by non-statisticians. Chapters 1 and 2 cover concisely selected elementary statistics as well as various survey sampling designs and statistics. Chapters 3 and 4 describe in detail the concepts of relative risk, odd ratios, and attributable risk. Chapters 5 and 6 deal with different kinds of adjustment

methods that can be applied to epidemiologic data. Chapters 7 and 8 describe followup studies, the use of life tables and person-year data. Later chapters compare results for various methods of adjustment and lay out in detail the data collection process in epidemiologic studies.

48. Kelsey, J.L., Thompson, W.D., & Evans, A.S. *Methods in Observational Epidemiology*. New York: Oxford University Press, 1986. (Also see new edition in 1996.)

This text is written for researchers who have background for elementary epidemiology and biostatistics. The book mainly focuses on observational epidemiologic studies but it also covers procedures and concepts in experimental epidemiologic studies. Chapters 4 to 8 in the book describe major types of study designs used in epidemiology, including the specific situations in which each is useful, the important issues to be considered in carrying them out, and methods of statistical analysis. Chapter 9 discusses techniques of epidemic investigation, and chapter 10 describes common methods of sampling in epidemiologic studies and presents methods and tables of investigation.

49. Selvin, S. *Statistical Analysis of Epidemiologic Data*. New York: Oxford University Press, 1995.

The aim of this book is to develop a clear understanding of issues important to epidemiologic data analysis without depending on sophisticated mathematics or advanced statistical theory. The level of this text is beyond introductory but short of advanced. It draws materials from the fields of statistics, biostatistics, vital statistics, and epidemiology. A number of statistical methods are surveyed in a way that should be useful to researchers concerned with the application of statistics to epidemiologic data. Additionally, these methods are chosen to illustrate general principles. For example, "jackknife" estimation (chapter 5) is an excellent way to estimate specific parameters from collected data but, at the same time, illustrates the application of a "computer-intensive" estimation method.

50. Weiss, N.S. *Clinical Epidemiology: The Study of the Outcome of Illness,* 2nd ed. New York: Oxford University Press, 1996.

This book intends to pull together a number of areas of research that are devoted to measuring and determining the factors that affect the outcome of illness. It gives these areas of research a collective label: clinical epidemiology. The author assumes that the readers have background in introductory epidemiology or biostatistics. The book begins with a description of the clinical context into which the research findings ought to fit, hence the discussion of decision analysis. Next, there are chapters on the evaluation of diagnostic tests with respect to both their accuracy and their measurable contribution to illness outcome. The book deals with both the experimental and nonexperimental approaches. The concluding chapter of the book concentrates on the role of studies that measure the natural history of illness. An appendix presents selected statistical methods commonly used in planning and analyzing data from clinical epidemiological data.

51. Woodward, M. *Epidemiology: Study Design and Data Analysis*. London: Chapman & Hall/CRC, 1999.

This book is about the quantitative aspects of epidemiological research. The authors assume that readers have some basic knowledge of statistics. The text goes through analytical methods for general and specific epidemiological study designs, leading to a discussion of statistical modeling in epidemiology in the final three chapters. Chapter 1 includes a broad introduction to study design, and later chapters are dedicated to particular types of design (cohort, case-control, and intervention studies). Chapter 8 concerns the problem of determining the appropriate size for a study.

3. Randomized Studies

52. Fleiss, J.L. *Design and Analysis of Clinical Experiments*. New York: John Wiley & Sons, 1986.

  The book focuses on experimental designs that are most relevant to clinical investigators. It also serves as a reference for biostatisticians who work in clinical settings. Compared with other texts on clinical trials, the book concentrates more on technical aspects of design and statistical analysis. In particular, it deals with the distinction between blocking and stratification, the use of tables of random permutations to carry out randomized assignments, the handling of unequal sample sizes, study of change estimation and interpretation of factorial effects, and how to analyze data from multicenter study and crossover study.

53. Kirk, R.E. *Experimental Design: Procedures for the Behavioral Sciences,* 2nd ed. Belmont, CA: Brooks/Cole, 1982.

  This volume on experimental design is meant to be both a text and a reference for researchers in the behavioral sciences. It covers different kinds of experimental designs, starting from the simplest completely randomized design to more complicated designs like the split-plot factorial designs and the fractional factorial designs. Compared to its first edition, the book adds in-depth coverage for multiple comparison procedures, the circularity assumptions associated with block design, the partition of interactions into interpretable contrast-contrast interactions, and the analysis of factorial designs with unequal sample sizes and missing observations. It also includes a chapter on general linear model approach.

54. Miettinen, O.S. The need for randomization in the study of intended effects. *Statistics in Med* 2:267-271.

  The author discusses the need for randomization as a means of controlling confounders that is accentuated in the study of intended effects (efficacy) as compared with unintended effects (toxicity). The indication for intervention is itself a confounder in the study of efficacy but not of toxicity. On the other hand, contraindications represent only a minor confounder even in toxicity research. Control of the indication in nonexperimental terms is commonly infeasible. The author proposes that the solution to these problems is the randomized clinical trial.

55. Piantadosi, S. *Clinical Trials: A Methodologic Perspective*. New York: John Wiley & Sons, 1997.

  This book attempts to acquaint investigators with ideas of design methodology that are also helpful in conducting, analyzing, and assessing clinical trials. The discussion in the book pertains to all types of trials: developmental, safety, comparative, and large-scale studies, although there is an emphasis on comparative designs. The author guides readers through the process of planning an experiment, putting together a study cohort, assessing data, and reporting results, and addresses the problems that are likely to confront any such study.

4. Quasi-Experiments

56. Campbell, D.T., & Stanley, J.C. *Experimental and Quasi-Experimental Design for Research*. Chicago: Rand McNally, 1963.

The book is the reprint of a chapter in the Gage's *Handbook of Research on Teaching*. It discusses alternatives in the arrangement or design of experiments, with particular regard to the problems of control of extraneous variables and threats to validity. The authors then discuss various kinds of threats to internal and external validity in different kinds of experimental designs. The authors classify study designs into pre-experimental, experimental, and quasi-experimental. Throughout the book, the authors try to illustrate how one can utilize idiosyncratic features of any specific research situation in designing unique tests of causal hypotheses.

57. Cook, T.D., & Campbell, D.T. *Quasi-Experimentation: Design & Analysis Issues for Field Settings*. Boston: Houghton Mifflin Company, 1979.

The classic text on quasi-experiment designs starts with a good discussion of plausible alternative interpretations of findings from field research. The core of the book described various quasi-experimental designs, such as research with nonequivalents groups and interrupted time-series experiments. The authors raise issues about analyzing results from such designs and how such analyses should be carried out. The book also includes chapters that deal with causal inferences from observational studies and the use of randomized experiments.

58. Salzberg, A.J. Removable selection bias in quasi-experiments. *American Statistician* 53(2):103-107.

Quasi-experiments are prone to selection bias, where the effect of the treatment is confounded with pre-existing differences in the treated and control sequence groups. Some quasi-experimental designs are immune to certain specific selection biases. The article shows that immunity to selection bias is not well characterized in terms of selection-by-time interaction, and in particular some good designs can be immune to certain types of selection bias even in the presence of such interaction.

59. Trochim, W.M.K. *Research Design for Program Evaluation: The Regression-Discontinuity Approach*. Beverly Hills, CA: Sage Publications, 1984.

The volume tries to make a case that we should move beyond the traditional thinking on quasi-experiments as a collection of specific designs and threats to validity toward a more integrated, synthetic view of quasi-experimentation as part of a general logical and epistemological framework for research. The papers in the edited volume cover topics like the role of judgment in quasi-experimental designs; the use of tailored designs; the crucial role of theory; the attention to program implementation; the importance of quality control; the advantages of multiple perspectives; evolution of the concept of validity; and the development of increasingly complex realistic analytic models.

5. Survey research

60. Rossi, P.H., Wright, J.D., & Anderson, A.A., eds. *Handbook of Survey Research*. New York: Academic Press, 1983.

The handbook is an introduction to current theory and practice of sample survey research. It address both the student who desires to master these topics and the practicing survey researcher who

needs a source that codifies, rationalizes, and presents existing theory and practice. Part I of the book sets forth the basic theoretical issues involved in sampling, measurement, and management of survey organizations. Part II deals mainly with hands-on, how-to-do-it issues, such as how to draw theoretically acceptable samples and how to write questionnaires. Part III considers the analysis of survey data with separate chapters for each of the three major multivariate analyses most in use, and one chapter on the uses of surveys in monitoring overtime trends.

6. Program Evaluation

61. Boruch, R.F., & Gomez, H. Sensitivity, bias, and theory in impact evaluations. *Professional Psychol* 8:411-434, 1977.

Ordinary design of experiment technology invites underpowered (insensitive) experiments because the measurement facts of life go unrecognized. The purpose of this article is to identify these measurement lapses and contribute to the development of more rigorous and socially beneficial program evaluations. Measurement should concern itself not only with reliability of dependent variable but, more importantly, with validity of measurement and with measurement (systematic observation) of the treatment variable. A technical appendix outlines a theory of measurement in field evaluation.

62. Chen, H.T. Theory-driven evaluation. In: *Advances in Educational Productivity* 7:15-34, 1998.

This chapter introduces the basic concepts, rationale, and methodology of designing and conducting theory-driven evaluations with an emphasis on application so that this evaluation approach could be widely applied in areas such as education.

63. Crits-Christoph, P., & Mintz, J. Implications of therapist effects for the design and analysis of comparative studies of psychotherapies. *J Consult Clin Psychol* 59(1):20-26, 1991.

The authors present technical reasons why therapists should be included as a random design factor in the nested analysis of (co)variance (AN[C]OVA) design commonly used in psychotherapy research. Incorrect specification of the ANOVA design can, under some circumstances, result in incorrect estimation of the error term, overly liberal *F* ratios, and an unacceptably high risk of type I errors. Both results from simulation studies and a reanalysis of data from 10 psychotherapy outcome studies are discussed, and implications of these results for future research designs are examined.

64. Pentz, M.A., Trebow, E.A., Hansen, W.B., MacKinnon, D.P., Dwyer, J.H., Johnson, C.A., Flay, B.R., Daniels, S., & Connack, C. Effects of program implementation on adolescent drug use behavior: The Midwestern Prevention Project (MPP). *Eval Rev* 14:264-289, 1990.

The study evaluates the relationship between level of program implementation and change in adolescent drug use behavior in the Midwestern Prevention Project (MPP), a school- and community-based program for drug abuse prevention. Trained teachers implement the program with transition year students. Implementation was measured by teacher self-report and validated by research staff reports. Adolescent drug use was measured by student self-report; an expired air measure of smoking was used to increase the accuracy of self-reported drug use. Regression analyses were used to evaluate adherence; exposure, or amount of implementation; and reinvention. Results showed that all schools assigned to the program condition adhered to the research by implementing the program. Exposure had a significant effect on minimizing the increase in drug use from baseline to 1 year. Exposure also had a larger magnitude of intervention effect than experimental group assignment. Reinvention did not affect

drug use. Results are discussed in terms of research assumptions about quality of program implementation, and possible school-level predictors of implementation.

65. Hawkins, J.D., Abbott, R., Catalano, R.F., & Gillmore, M.R. Assessing effectiveness of drug abuse prevention: Implementation issues relevant to long-term effects and replication. In: Leukefeld, C.G., & Bukoski, W.J., eds., *Drug Abuse Prevention Intervention Research: Methodological Issues*. *National Institute on Drug Abuse Research Monograph 107*. DHHS Pub. No. (ADM)91-1761. Washington, DC: Supt. of Docs., U.S. Govt. Print. Off., 1991, pp. 213-234.

The chapter outlines a strategy for assessing the long-term effects of drug abuse prevention interventions in replicable studies. It consists of a theory-driven data collection and analysis approach that implies the need to link proximal intervention outputs to more distal outcomes desired. The approach also requires prospective longitudinal followup studies in which complete panels of subjects who vary with respect to the levels of key predictor constructs are followed up through the period of their highest risk for drug use.

66. Leithwood, K.A., & Montgomery, D.J. Evaluating program implementation. *Eval Rev* 4:193-214,1980.

The authors describe a methodology for evaluating program implementation. Requirements for such a methodology are derived from an analysis of the functions to be performed by implementation evaluation, the nature of the program being implemented, and characteristics of the implementation process. Central features of the methodology involve procedures for the development of a multidimensional profile of the program as it evolves in practice from non- to full implementation. The profile then serves as the basis for instrument development; data collected through the instruments locate program user behavior in relation to the dimensions and levels of use described by the profile. Uses of resulting data to serve program management goals are outlined.

67. Rich, K.C. Discussion: Research environment and use of multicenter studies in perinatal substance abuse research. In: Kilbey, M.M., & Asghar, K., eds. *Methodological Issues in Epidemiological, Prevention, and Treatment Research on Drug-Exposed Women and Their Children. National Institute on Drug Abuse Research Monograph 117*. DHHS Pub. No. (ADM)92-1881. Washington, DC: Supt. of Docs., U.S. Govt. Print. Off., 1992, pp. 293-304.

The chapter discusses the challenges presented by research environment. Often investigators have to contend with political, social, environmental, and medical factors that could determine the type and content of studies that can be performed and the likelihood of their success. The latter half of the chapter discusses the advantages and challenges of multicenter collaborative studies.

68. Wortman, P.M. Evaluation research: A methodological perspective. *Am Rev Psychol* 34:223-260, 1983.

The review chapter first took a historical perspective and examines the predominant methodological school of thought from the "early days" in the development of evaluation research. It then considers more recent development and concerns in the field. The core of the chapter consists of the examination of three evaluative methods that have becoming increasingly important in the field: (1) social experimentation; (2) meta-analysis; and (3) cost-effectiveness analysis.

IV. STATISTICAL ANALYSIS

A. Statistical Models and Data Analysis

1. Linear Models (Regression, Analysis of Variance, Analysis of Covariance)

69. Afifi, A.A., & Clark, V. *Computer-Aided Multivariate Analysis,* 3rd ed. London: Chapman and Hall, 1996.

   The book describes statistical techniques that are useful for researchers and presents them in a way understandable to people who have limited knowledge of statistics. The book describes the basic models behind all the analysis and discusses the underlying assumptions. Each chapter includes a discussion of computer programs that are suitable for performing a particular analysis. The author also discuss data entry, database management, data screening, data transformations, as well as multivariate data analysis. This edition also contain a new chapter on log-linear analysis of multiway frequency tables.

70. Cohen, J., & Cohen, P. *Applied Multiple Regression/Correlation Analysis for the Behavioral Sciences,* 2nd ed. Hillsdale, NJ: Lawrence Erlbaum Associates, 1983.

   The book is intended to be a text for courses in multiple regression/correlation (MRC) methods. It offers a thorough treatment of the techniques and an integrated conceptual system on these methods. Part I discusses basics. Chapter 1 introduces multiple regression/correlation analysis as a general data-analytic system. Chapters 2 and 3 provide detailed discussions on bivariate and multiple regression/correlation. Chapter 4 considers sets of independent variables as units of analysis. Part II deals with use of different measurement scales in MRC. It also discusses the handling of missing data and interaction. Part III discusses various applications of MRC: causal models in MRC, ANCOVA via MRC, repeated measurement and matched subjects designs, MRC, and other multivariate methods.

71. Cook, R.D., & Weisberg, S. *Residuals and Influence in Regression*. London: Chapman and Hall, 1982.

   The book contains a comprehensive account of diagnostic methods for detecting inadequacies in the fit statistics in data analyses based on linear regression models. The authors also extend their discussion of the methods to more complicated problems. The use of graphical procedures is emphasized, and most techniques discussed are illustrated in over 35 examples with more than 50 figures. The book is written at an intermediate level and is appropriate for those who are familiar with, or currently are learning, the methods of standard linear regression.

72. Draper, N.R., & Smith, H. *Applied Regression Analysis,* 3rd ed. New York: John Wiley & Sons, 1998.

   The classic text on regression analysis offers a clear, thorough presentation of concepts and applications as well as a complete, easily accessible introduction to the fundamentals of regression analysis. The reader only requires basic knowledge of elementary statistics. The text focuses on the fitting and checking of both linear and nonlinear regression models, using small and large data sets, with pocket calculators or computers. This latest edition of the book features separate chapters on multicollinearity, generalized linear models, mixture ingredients, geometry of regression, robust regression, and resampling procedures.

73. Elashoff, J.D. Analysis of covariance: A delicate instrument. *American Educational Research Journal*, 6:383-401, 1969.

This book gives a clear and comprehensive exposition of the technique of ANCOVA. It discusses what it really does and does not do, the advantages and limitations of the technique, and the conditions the data must satisfy for covariance analysis to be a valid technique.

74. Hawkins, D.M. *Identification of Outliers*. London: Chapman and Hall, 1980.

The book is a comprehensive and integrated assessment of the methods of identifying statistical outliers in a mass of data. It brings together existing findings in the field, and it emphasizes on the optimal procedures. The author describes new concepts and test procedures and compares them to those that they supersede. An extremely useful feature of the book are the tables of fractiles of a comprehensive set of optimal outlier test statistics, some of which are defined for the first time.

75. Huitema, B.E. *The Analysis of Covariance and Alternatives*. New York: John Wiley & Sons, 1980.

The book provides research workers in the behavioral and biological sciences with an applied and comprehensive treatment of the analysis of covariance and other alternative procedures. It is divided into three parts. Part I includes a brief review of statistical inference through simple analysis of variance and regression, followed by a diagrammatic illustration of the underlying rationale of ANOCA. Then the general linear regression approach to ANOVA and ANOCOVA is introduced. This part also deals with multiple comparison procedures, assumptions, design, and interpretation problems. Part II covers varieties of ANCOVA, such as procedures that deal with multiple covariates, nonlinearity, multiple factors, and multiple dependent variables. Part III presents alternatives to standard parametric ANCOVA (e.g., rank ANCOVA, Johnson-Neyman techniques, and true-score ANCOVA) and standardized change score analysis.

76. Morrison, D.F. *Applied Linear Statistical Methods*. Englewood Cliffs, NJ: Prentice Hall, 1983.

Linear statistical inference encompasses the fitting of lines and planes by least squares, the analysis of variance for experimental designs, correlation, traditional multivariate analysis, and some of the time series analyses. The book covers some techniques from these areas with the emphasis on the underlying assumptions, mathematical models, and applications of the methods.

77. Morrison, D.F. *Multivariate Statistical Methods,* 3rd ed. New York: McGraw-Hill, 1990.

The book is written to provide investigators in the life and behavioral sciences with an elementary source for multivariate techniques. It is also meant to be a textbook for graduate courses on multivariate statistical methods. The book provides a review of essential univariate statistical concepts in the first chapter, and the second chapter covers matrix algebra. Chapter 3 discusses standard results on multinormal distribution, the estimation of its parameters, and correlation analysis. All these are essential background for the understanding of multivariate statistics. Later chapters deal with various multivariate analyses, from hypothesis testing of means, MANOVA to discriminant functions. Chapter 7 deals with inferences from covariance matrices. Chapters 8 and 9 deal with principal components and factor analysis.

78. Neter, J., Kutner, M.H., Nachtsheim, C.J., & Wasserman, W. *Applied Linear Statistical Models,* 4th ed. Chicago: Irwin, 1996.

A key feature of this book is its presentation of application of the linear statistical models in regression, analysis of variance, and experimental design. The same notation is used for all three areas. The notion of a general linear statistical model, in the context of regression models, is carried over to analysis of variance and experimental design models to bring out their relation to regression models. In addition to more conventional topics in regression, ANOVA, and experimental designs, the authors include topics that are often slighted, though important in practice, such as the model-building process for regression and use of indicator variables. The book also emphasizes residual analysis and other diagnostics for examining the appropriateness of a statistical model, as well as remedial measures one can use when the model is not appropriate.

79. Pedhazur, E.J. *Multiple Regression in Behavioral Research,* 3rd ed. New York: Harcourt Brace College Publishers, 1997.

The major focus of the book is multiple regression and its application. It also includes chapters on other multivariate analytic techniques. Part I of the text, chapters 1 to 8, introduces the foundation of multiple regression. It covers simple regression and diagnostics in regression analysis, matrix operation, and partial and semipartial correlation. Part II deals with the use of multiple regression in explanatory research. Chapters 9, 10, and 13 address the analyses of designs with continuous variables. Chapters 11 and 12 describe how to deal with categorical variables in multiple regression, in particular the use of MR for ANOVA designs. Chapters 14 and 15 deal with attribute-treatments-interaction (ATI) and ANCOVA designs. The book also has chapters on multilevel analysis, logistic regression, structural equation models, discriminant analysis, and canonical analysis.

80. Tabachnick, B.G., & Fidell, L.S. *Using Multivariate Statistics*. New York: HarperCollins, 1996.

The book discusses multivariate statistical technique. The authors discuss considerations involved in determining the most appropriate technique, screening data for compliance, preparing followup analyses, and preparing the results for journal publication. Each chapter deals with each technique's specific research questions, assumptions, and limitations. Small and large sample examples, special topics, and results are included in each chapter. Topics covered in the book include multiple regression, canonical correlation, multiway frequency analysis, analysis of covariance, factor analysis, structural equation modeling, and logistic regression.

2. Linear Models (Mixed-Effects and Variance Components Models, Random Coefficient Models, and Hierarchical/Multilevel Models)

81. Bryk, A.S., & Raudenbush, S.W. *Hierarchical Linear Models: Applications and Data Analysis Methods*. Newbury Park, CA: Sage Publications, 1992.

The introductory text explicates the theory and use of hierarchical linear models (HLM), through the use of working examples and lucid explanations. The presentation remains reasonably nontechnical by focusing on three general research purposes—improved estimation of effects within an individual unit, estimating and testing hypotheses about cross-level effects, and partitioning of variance and covariance components among levels. The volume describes use of both two- and three-level models in organizational research and studies of individual development and meta-analysis applications and concludes with a formal derivation of the statistical methods used in the book.

82. Goldstein, H., & McDonald, R.P. A general model for the analysis of multilevel data. *Psychometrika* 53(4):455-467, 1988.

The authors developed a general model for the analysis of multivariate multilevel data structures. They include special cases like repeated measures designs, multiple matrix samples, multilevel latent variable models, multiple time series, and variance and covariance component models.

83. Kreft, I.G.G., & De Leeuw, E.D. *Introducing Multilevel Modeling*, Thousand Oaks, CA: Sage Publications, 1998.

The authors introduce the multilevel modeling approach to researchers in social sciences. The book covers practical issues and potential problems of doing multilevel analyses and the author's approach is user-oriented, keeping formal mathematics and statistics to a minimum. Other key features of the book include the use of worked examples using real data sets, analyzed using the latest computer package for multilevel modeling.

84. Longford, N.T. *Random Coefficient Models*. Oxford: Clarendon Press, 1993.

The book presents an elementary and systematic introduction to modeling of between-cluster variation, with emphasis on substantive interpretation. The text contains details of computational methods for estimation with random coefficient models, as well as a number of examples. Other than the basic random coefficient model, the book also deals with models with multiple layers of nesting, measurement error models for multilevel data, and a generalization of the random coefficient models to the class of generalized linear models.

85. Raudenbush, S.W. Educational applications of hierarchical linear models: A review. *Journal of Educational Statistics* 13(2):85-116, 1988.

This paper reviews use of hierarchical linear models to deal with multilevel data in educational research. It discusses the estimation of both within- and between-group parameters in these models and reviews estimation theory and application of such models. Also, the logic of these methods is extended beyond the paradigmatic case to include research domains as diverse as panel studies, meta-analysis, and classical test theory. Estimation theory is reviewed from Bayes and empirical Bayes viewpoints, and the examples considered involve data sets with two levels of hierarchy.

86. Raudenbush, S.W., & Chan, W.S. Application of a hierarchical linear model to the study of adolescent deviance in an overlapping cohort design. *J Consult Clin Psychol* 61:941-951, 1993.

The paper illustrates the use of the hierarchical linear models in assessing the psychometric properties of an instrument for studying change, compares the adequacy of linear and curvilinear growth models, controls for time invariant and time-varying covariates, and links overlapping cohorts of data. The authors employ data on attitudes toward deviance during adolescence.

87. Searle, S.R., Casella, G., & McCulloch, C.E. *Variance Components*. New York: Wiley, 1992.

The book is written for research workers who have interests in the use of mixed models and variance components for statistically analyzing data. For students the book is suitable for linear models courses that include something on mixed models, variance components, and prediction. The introductory

chapter of the book describes fixed, random, and mixed models and uses nine examples to illustrate them. The latter chapters describe the history of variance component estimation and different methods of estimation in one-way classification with or without balanced data. Chapters 4 and 5 deal with ANOVA estimation in general. Chapter 6 covers ML and REML estimation, and chapter 7 describes the prediction of random effects using best prediction (BP), best linear prediction (BLP), and best linear unbiased prediction (BLUP). Chapters 8 through 12 of the book cover specialized topics, such as computation of ML and REMI estimates; Bayes estimation and hierarchical models; and binary and discrete data.

3. Generalized Linear Models (Log-Linear Models and Logit Models)

88. Agresti, A. *The Analysis of Ordinal Categorical Data*. New York: John Wiley, 1984.

The book provides an introduction to basic descriptive and inferential methods for categorical data and gives thorough coverage of later developments. Special emphasis is placed on interpretation and application of methods including an integrated comparison of the available strategies for analyzing ordinal data. The book also discusses implementation of methods using computer packages such as SAS, SPSS[x], and GLIM.

89. Agresti, A. *Categorical Data Analysis*. New York: Wiley, 1990.

The book describes the most important methods of analyzing categorical data. It offers a unified presentation of modeling using generalized linear models and emphasize loglinear and logit modeling techniques. Some special topics covered in the book include methods for repeated measurement data, prescriptions for how ordinal variables should be treated differently than nominal variables, derivations of basic asymptotic and fixed-sample-size inferential methods, and discussion of exact small sample procedures.

90. Andersen, E.B. *The Statistical Analysis of Categorical Data,* 3rd ed. Berlin: Springer-Verlag, 1994.

The book can be used as a textbook for a graduate course in categorical data analysis. Topics covered included statistical inference in categorical data analysis; log-linear models and generalized linear models; two-way, three-way, and multidimensional contingency tables; incomplete tables; separability and collapsibility; the logit model and logistic regression analysis; models for the interactions; correspondence analysis; latent structure analysis; and latent class models. The treatment of statistical methods for categorical data is based on development of models and on derivation of parameters estimates, test quantities, and diagnostics for model departures. All the introduced methods are illustrated by data sets and accompanied by exercises.

91. Bishop, Y.M.M., Fienberg, S.E., & Hollan, P.W. *Discrete Multivariate Analysis: Theory and Practice*. Cambridge, MA: MIT Press, 1975.

The text deals with analyses of discrete multivariate data, in particular those in the form of cross-classifications. Through the presentation of parametric models, sampling schemes, basic theory, practical examples, and advice on computation, the book serves as a ready reference for various users. The authors start with a chapter on structural models, then move on with chapters on MLE estimation and methods of goodness of fit. They also talk about practical aspects of model fitting and topics like incomplete tables, improved multinomial estimators, asymptotic methods, Markov models, and some other procedures useful for analyzing discrete multivariate data.

92. Cliff, N. *Ordinal Methods for Behavioral Data Analysis*. Mahwah, NJ: Lawrence Erlbaum Associates, Inc., 1996.

The book treats ordinal methods in an integrated way rather than as a compendium of unrelated methods. It emphasizes that the ordinal quantities are highly meaningful in their own right, not just as stand-ins for more traditional correlations or analyses of variance. In fact, since the ordinal statistics have desirable descriptive properties of their own, the book treats them parametrically, rather than nonparametrically. The author discusses how ordinal statistics can be applied in a much wider set of research situations than has usually been thought, and shows that they can often come closer to answering the researcher's primary questions than traditional ones can.

93. Clogg, C.C., & Shihadeh, E.S. *Statistical Models for Ordinal Variables*. Thousand Oaks, CA: Sage Publication, 1994.

The book deals with the latest development in methods for analyzing ordinal data. It incorporates ordinal and even numerical information into the classical log-linear analysis of multidimensional contingency tables. It also builds on methods introduced by Goodman, Haberman, Fienberg, and Clogg, and it presents them in a unifying framework. The authors stressed that the book is gearing toward the applications of new models and methods for analysis of ordinal variables in the social sciences.

94. DeMaris, A. A tutorial in logistic regression. *Journal of Marriage and the Family* 57:956-968, 1995.

This article discusses some major uses of the logistic regression model in social data analysis. To illustrate the use of the technique, the author compares it to linear regression. He begins with a discussion of the modeling of a binary dependent variable and then shows the modeling of polytomous dependent variables, considering cases in which the values are alternately unordered, then ordered. Techniques are illustrated throughout using data from the 1993 General Social Survey (GSS).

95. Everitt, B.S. *The Analysis of Contingency Tables,* 2nd ed. London: Chapman and Hall, 1992.

This book gives a comprehensive account of the analysis of contingency tables, written at a level suitable for the applied researcher. In this new edition more material is included such as logistic regression models for tables with ordered categories and for response variables with more than two categories. A brief account is also given on correspondence analysis, a recently developed technique. The methods of analysis described in this book are relevant to research workers and graduate students dealing with data from surveys, particularly in the areas of psychiatry, social sciences, and psychology.

96. Fleiss, J.L. *Statistical Methods for Rates and Proportions*. New York: John Wiley, 1981.

The book is concerned with the analysis of categorical data, with emphasis on applications to health sciences. It covers theoretical and practical issues related to rates and proportions, such as related probability theory, assessing significance in a fourfold table, sample size determination, and randomization. The author then discusses three different sampling methods and their analysis, namely naturalistic or cross-sectional studies, prospective and retrospective studies, and controlled comparative studies. Other topics covered include analysis of data from matched samples, comparison of proportions from many samples, combining evidence from fourfold tables, measurement and control of misclassification errors, and standardization of rates.

97. Goodman, L.A. *Analyzing Qualitative/Categorical Data*. Cambridge, MA: Abt Books, 1978.

The book consists of a collection of papers written by Leo Goodman, who led the early development of log-linear models. It covers readings on both log-linear models and latent-structure analysis. It has five parts: (1) the logit model; (2) the general log-linear model; (3) Davis on Goodman's approach; (4) latent structure and scaling models; and (5) some extensions to the Goodman system.

98. Goodman, L.A. *The Analysis of Cross-Classifications Having Ordered Categories*. Cambridge, MA: Harvard University Press.

The book is a collection of papers written by Leo Goodman on the analysis of ordinal data. It also includes work by Cliff Clogg, which describes the applications of association models (chapter 8) and the analysis of multiway cross-classifications having ordered categories (chapter 9). Chapters 1 to 4 of the book deal with the use of log-linear models in three different contexts: the analysis of the joint distribution in a cross-classification, the analysis of dependence, and the analysis of association. Chapters 5 and 6 develop further analysis of association, in comparison to earlier models developed by Karl Pearson and R.A. Fisher. Chapters 7, 8, and 9 provide examples of application of association models.

99. Hagenaars, J.A. *Categorical Longitudinal Data*. Newbury Park, CA: Sage Publications, 1990.

This book focuses on the analysis of categorical data obtained at a few discrete points in time, and log-linear model occupies a central position in the book. Special attention is paid to log-linear models with latent variables. After a short introductory chapter on the types of analyses of social change, chapter 2 describes the essential features in log-linear models, and chapter 3 talks about log-linear models with latent variables. Chapters 4 to 7 form the core of the book, and they touch on panel analysis and trend and cohort analysis. At the end of the book, chapter 8 summarizes the author's main arguments and presents several computer programs that implement ideas in the book.

100. Hosmer, D.W., Jr., & Lemeshow, S. *Applied Logistic Regression*. New York: Wiley, 1989.

The book is the first focused introduction to the model. The latter is developed by approaching logistic regression via a linear regression point of view, rather than by means of contingency tables. Emphasis is placed on effective modeling strategies, including variable selection methods and the interpretation and presentation of results. The book also covers topics like logistic regression diagnostics. It further discusses the application of the method with different sampling models and its use in matched case-control studies. The last chapter is devoted to special topics on polytomous logistic regression and use of logistic regression to survival data.

101. Lindsey, J.K. *Modelling Frequency and Count Data*. Oxford: Clarendon Press, 1995.

The book is structured around the distinction between independent events occurring to different individuals, resulting in frequencies, and repeated events occurring to the same individuals, yielding counts. It presents standard as well as more recently developed models of categorical data. The author also demonstrates that much of modern statistics can be seen as special cases of categorical data models; both generalized linear models and proportional hazards models can be fitted as log linear models. More specialized topics such as Markov chains, over-dispersion, and random effects are also covered.

102. Sobel, M.E. The analysis of contingency tables. In: Arminger, G., Clogg, C.C., & Sobel, M.E., eds. *A Handbook for Statistical Modeling in the Social and Behavioral Sciences*. New York: Plenum, 1992, pp. 252-303.

The chapter discusses in detail various forms of log-linear models. It starts with a brief history of the development of log-linear models. Section 2 uses several examples to introduce the reader to the log-linear model. Section 3 discusses the use of the odds ratio as a measure of association in two-way and three-way tables. Section 4 introduces models for the two-way table, Section 5 extends the discussion to three-way tables, and section 6 takes up the case of higher-way tables. Section 7 discusses estimation theory for the models. Section 8 discusses residuals and model selection procedures, and section 9 discusses computer programs that can be used to fit the models considered herein.

103. von Eye, A., & Clogg, C.C. *Categorical Variables in Developmental Research: Method of Analysis*. San Diego: Academic Press, 1996.

The volume presents methods for analysis of categorical data in developmental research. The book covers a broad range of methods, concepts, and approaches. It is divided into four sections: (1) measurement and repeated observations of categorical data; (2) catastrophe theory; (3) latent class and log-linear models; and (4) applications.

104. von Eye, A., & Niedermeier, K.E. *Statistical Analysis of Longitudinal Categorical Data in the Social and Behavioral Sciences: An Introduction with Computer Illustration.* Mahwah, NJ: Lawrence Erlbaum Associates, 1999.

The book provides a comprehensive resource for analyzing a variety of categorical data. It emphasizes the application of many recent advances of longitudinal categorical statistical methods. Each chapter provides basic methodology, helpful applications, examples using data from all fields of the social sciences, computer tutorials, and exercises. After defining categorical data and reviewing the basics of log-linear modeling, the book examines log-linear modeling for repeated observations, chi-square partitioning, prediction analysis, and configural frequency analysis.

4. Latent Variable Models (Factor Analysis)

105. Bartholomew, D.J. *Latent Variable Models and Factor Analysis*. London: Griffin, 1987.

The book offers a unified treatment of latent variable models, which include factor analysis, latent class, and latent trait analysis. After earlier chapters describe these models, chapter 4 of the book discusses common elements of these models and the sufficiency principle. Later chapters deal with models and methods for binary and polytomous data.

106. Comrey, A.L., & Lee, H.B. *A First Course in Factor Analysis,* 2nd ed. Hillsdale, NJ: Lawrence Erlbaum Associates, 1992.

The book introduces readers to the theory and practice of factor analysis. Step by step, the authors first describe the derivation and assumptions of the factor analytic model. Then they examine various methods of factor extraction and rotations. Chapters 8 and 9 describes various designs in factor analysis. Chapter 10 deals with the interpretation and application of the analytic results. The authors then illustrate the use of factor analysis in one of their projects. The last three chapters of the book deal with

confirmatory factor analysis, structural equation models, and computer programs that handle factor analysis.

107. Graham, J.W., & Collins, N.L. Controlling correlational bias via confirmatory factor analysis of MTMM data. *Multivariate Behav Res* 26:607-629, 1992.

The two commonly used CFA analysis carried out on MTMM data either average the various measures of each trait or estimate only relationships between MTMM traits and the outside variables. The authors show that both methods produce equally highly biased parameter estimates when the actual correlations between MTMM method factors and the outside variables are substantial. An algebraic explanation and a simulated data illustration are given for the bias due to misspecification. Also, the problem is illustrated with a brief empirical example. Implications for applied research are discussed.

108. Gorsuch, R.L. *Factor Analysis*, 2nd ed. Hillsdale, NJ: Lawrence Erlbaum Associates, 1983.

The text is meant to be both a textbook for graduate student as well as a reference on factor analysis. It focuses on when and how to use the technique. Derivations of the mathematical models used in factor analysis are given. After the introduction in chapter 1, chapters 2, 3, 6, 8, 9, and 11 cover exploratory factor analysis, chapter 7 discusses the use of canonnical correlations to test hypotheses, and chapters 12 and 16 discuss the relevance of scoring techniques and replicability for all multivariate techniques. Chapters 17 and 18 provide a final overview of when each of the multivariate techniques should be used.

109. Long, J.S. *Confirmatory Factor Analysis: A Preface to LISREL*. Beverly Hills, CA: Sage Publications, 1983.

The book presents the basic CFA equations and assumptions. It provides a thorough discussion of identification in such models and compares various methods of statistical estimation, including unweighted least squares, generalized least squares, and maximum likelihood methods. The author focuses on two basic applications of the CFA, the first a general discussion of its application to the multimethod-multitrait model, and the second a discussion of a specific mode of psychological disorders. The theoretical advantages of the confirmatory over the exploratory model are emphasized and demonstrated.

110. McDonald, R.P. *Factor Analysis and Related Methods*. Hillsdale, NJ: Lawrence Erlbaum Associates, Publishers, 1985.

The author introduces the readers to the technique of factor analysis in a nonmathematical manner. The book begins with a chapter that covers basic and key concepts of common factor analysis, followed by chapters on exploratory common factor analysis and confirmatory factor analysis. In chapters 4 and 7, the author extends his discussion to models for linear structural relations and item response theory. In chapters 5 and 6, he deals with the problem of factor scores and the problems of relationships between factor analyses.

5. Latent Variable Models (Structural equation modeling)

111. Arminger, G., & Schoenberg, R.J. Pseudo maximum likelihood estimation and a test for misspecification in mean and covariance structure models. *Psychometrika* 24:409-425, 1989.

        The paper discusses the use of pseudo maximum likelihood in structural equation modeling when there is model misspecifications in mean and covariance structure models. The assumptions of multivariate normality in the variables is violated and ML method of estimation no longer valid. At the same time, LR, score and Wald test statistics will not converge to central chi-square. The authors also propose a Hausman-type test against this form of misspecification.

112. Bentler, P.M. Comparative fit indexes in structural models. *Psychol Bull* 107:238-246, 1990.

        The author proposes the use of a coefficient that summarizes the relative reduction in the noncentrality parameters of two nested models. Two estimators of the coefficient yield new normed fit index (CFI) and the nonnormed fit index (NNFI). CFI avoids the underestimation of fit often noted in small samples for Bentler and Bonett's (1980) normed fit index (NFI). FI is a linear function of Bentler and Bonett's NNFI that avoids the extreme underestimation and overestimation often found in NNFI. The author provides an example that illustrates the behavior of these indexes under conditions of correct specification and misspecification.

113. Bollen, K.A. Total, direct, and indirect effects in structural equation models. In: Clogg, C., ed. *Sociological Methodology 1987*. San Francisco: Jossey-Bass, 1987, pp. 37-68.

        In this paper, Bollen reviews the decomposition of effects for the structural equation models. It also clarifies the definition of total effects and the alternative meanings of specific indirect effects and the techniques of calculating them. The paper also proposes a general definition of specific effects, a definition that includes the effects transmitted by any path or combination of paths in a model.

114. Bollen, K.A. *Structural Equations with Latent Variables*. New York: John Wiley & Sons, Inc., 1989.

The book offers a comprehensive treatment of structural equation (LISREL) models. It can be used as an introduction as well as a more advanced reference. The author begins by discussing simple models and then builds toward the general model. The text treats procedures such as path analysis, recursive and nonrecursive models, classical econometrics, and confirmatory factor analysis as special cases of a common model.

115. Bollen, K.A., & Long, J.S. *Testing Structural Equation Models*. Thousand Oaks, CA: Sage Publications, 1993.

        The book focuses on testing model fit and respecification in structural equation modeling. Chapters in the book were written by researchers in the field who have played major roles in shaping the debate over the two major steps in SEM. These authors wrote about the use and evaluation of different kinds of goodness-of-fit indices in SEM models. The book also includes chapters that discuss model selection and power evaluation in SEM.

116. Browne, M.W. Asymptomatically distribution-free methods for the analysis of covariance structures. *Br J Math Stat Psychol* 37:62-83,1984.

The author derives methods for obtaining tests of fit of structural models for covariance matrices and estimator standard errors that are asymptotically distribution-free. He also provides modifications to standard normal theory tests and standard errors, which make them applicable to the wider class of elliptical distributions. The proposed methods were examined by conducting a random sampling experiment.

117. Hayduk, L.A. *Structural Equation Modeling with LISREL: Essentials and Advances*. Baltimore: The John Hopkins University Press, 1987.

The book introduces structural equation modeling to readers who have no experience with the technique. In the first four chapters, the author goes over basic statistical concepts and skills readers need for understanding SEM. Chapters 5 and 6 deal with estimation and test of model fit. Chapters 7, 8, 9, and 10 discuss how to interpret LISREL results and the fitting multiple group models and means models.

118. Hoyle, R.H., ed. *Structural Equation Modeling: Concepts, Issues, and Application*. Thousand Oaks, CA: Sage Publications, 1995.

The edited book includes chapters on major aspects of the structural equation modeling approach to research design and data analysis. Various authors contributed chapters that cover the following topics: basic concepts and fundamental issues in SEM; model specification and related issues; estimation and testing in SEM; SEM with nonnormal variables; evaluating model fit; statistical power in SEM; objectivity and reasoning in science and SEM; and various applications of SEM.

119. Hoyle, R.H., & Smith, G.T. Formulating clinical research hypotheses as structural equation models: A conceptual overview. *J Consult Clin Psych* 62(30):429-440, 1994.

In the article, the authors provide a conceptual overview of the strategies and issues associated with formulating and evaluating various clinical research hypotheses as structural equation models. The paper begins with a sketch of the structural equation modeling approach to research design and data analysis. Then a series of clinical research hypotheses in structural equation modeling terms are presented. The authors conclude with a section on inferring causality from structural equation models.

120. MacCallum, R.C., Roznowski, M., & Necowitz, L.B. Model modifications in covariance structure analysis: The problem of capitalization on chance. *Psychol Bull* 111(3):490-504, 1992.

The paper discusses in detail the issue of model modification and explores that empirically through sampling studies using two large sets of data. The process of model modification, which is used commonly to improve model fit, is data-driven and so the results from such procedures are susceptible to capitalization on chance characteristics of the data. The authors found that over repeated samples, model modifications may be very inconsistent and cross-validation results may behave erratically. The authors recommend the use of alternative a priori models.

121. Marcoulides, G.A., & Schumacker, R.E. *Advanced Structural Equation Modeling: Issues and Techniques*. Mahwah, NJ: Lawrence Erlbaum Associates, 1996.

The book introduces the latest issues and developments in SEM techniques. The topics selected include models for multitrait-multimethod (MTMM) matrix analysis, matrix analysis, nonlinear structural equation models, cross-domain analyses of change over time, structural time series models, bootstrapping techniques in the analysis of mean and covariance structure, limited information estimators, dealing with incomplete data, problems with equivalent models, and an evaluation of incremental fit indices.

122. Maruyama, G.M. *Basics of Structural Equation Modeling*. Thousand Oaks, CA: Sage Publications, 1998.

The book describes the logic underlying structural equation modeling approaches, describes how SEM approaches relate to techniques like regression and factor analysis, analyzes the strengths and shortcomings of SEM as compared to alternative methodologies, and explores the various methodologies for analyzing structural equation modeling. Throughout the book, the author uses a single data set to demonstrate a variety of techniques ranging from path analysis to panel analysis to confirmatory analysis to latent variable structural equation modeling.

123. Schumacker, R.E., & Lomax, R.G. *A Beginner's Guide to Structural Equation Modeling.* Mahwah, NJ: Lawrence Erlbaum Associates, 1996.

The book introduces students and researchers to the technique of structural equation modeling. The authors focus on the conceptual steps involved in analyzing theoretical models, including theory- or research-driven model specification, parameter estimation, model testing, interpretation of fit indices, and respecification of the model. Two popular software packages—EQS5 and LISREL8-SIMPLIS—are used in data examples throughout the book.

124. Sörbom, D. Structural equation models with structured means. In: Jöreskog, K.G., & Wold, H., eds. *Systems Under Indirect Observation: Causality, Structure, Prediction. Vol. 1*. Amsterdam: North-Holland, 1982, pp. 183-195.

The paper discusses how to handle multiple group analysis in LISREl. Such an approach allows one to compare groups of individuals, e.g., to compare the means for certain constructs among these groups. The paper used the Head Start Summer Program data to illustrate the analysis. In detail, it describes the general model and its estimation.

125. Sörbom, D. Model modification. *Psychometrika* 54(3):371-384, 1989.

The paper discusses the formulation of the "modification index" in LISREL program, which can be used as a guide in the search for a "better" model in covariance structure analysis. In statistical terms, the proposed index measures how much we will be able to reduce the discrepancy between model and data, as defined by a general fit function, when one parameter is added or freed or when one equality constraint is relaxed. The index also takes into account changes in all the parameters of the model when one particular parameter is freed.

6. Classification (Cluster Analysis)

126. Arabie, P., Hubert, L.J., & De Soete, G. *Clustering and Classification*. Singapore: World Scientific, 1996.

The edited book deals with theories and applications on classification. It is a compendious scholarly review of the field by some of its eminent contributors. The chapter on "combinatorial data analysis" includes the field of clustering apart from probabilistic approaches. It is followed by chapters on "hierarchical models," "complexity theory," and "neural networks." Later chapters cover topics on clustering validation by simulation, statistical inference on cluster analysis, cluster analysis in Japan, and clustering and multidimensional scaling in Russia. The last chapters of the book review work on two-way clustering of 0-1 data and the fitting of tree models and network models.

127. Blashfield, R.K., & Aldenderfer, M.S. The methods and problems of cluster analysis. In: Nesselroade & Cattell, eds. *Handbook of Multivariate Experimental Psychology.* New York: Plenum Press, 1988, pp. 447-473.

The chapter is an overview of cluster analysis. After briefly describing the history of the development of the technique, the authors go into detail about the various cluster analysis methods that are commonly used by researchers. Then the authors discuss the concept of similarity and conclude their chapter with some unresolved problems of cluster analysis and future direction of research in the field.

128. Everitt, B. *Cluster Analysis*. New York: Halsted Press, 1980.

The text provides a nonmathematical account of the techniques of cluster analysis. After reviewing the general purpose of conducting cluster analysis, the choice of variable, and the measurement of similarity and distance, the author reviews some of the clustering techniques, followed by a discussion of the problems of cluster analysis and an empirical investigation of some methods of cluster analysis. The author concludes by comparing the advantages and disadvantages of different techniques and makes suggestions on using clustering techniques in practice.

130. Bergman, L.R. You can't classify all of the people all of the time. *Multivariate Behavioral Research* 23:425-441, 1988.

When performing a classification study, it is sometimes a sound strategy not to classify all subjects but to leave a residue of unclassified entities to be analyzed separately. Starting from an interactional paradigm, theoretical reasons for this approach were given. The method RESIDAN, which uses a residue, is presented. It is argued that the concept of antitype (rare pattern) has theoretical significance and could be studied within the presented framework.

131. Bergman, L.R. A pattern-oriented approach to studying individual development: Snapshots and processes. In: Cairns, R.B., Bergman, L.R., & Kagan, J., eds. *The Individual as a Focus in Developmental Research*. New York: Sage Publications, 1996.

The implications of a person-oriented perspective for the study of individual development are discussed and various methodological solutions are suggested. Cluster analysis procedures are emphasized, and both a direct longitudinal approach and a cross-sectional approach followed by linking of the results at adjacent time points are presented. The program LICUR was used, and steps for using it

are described. LISREL is also used in the paper to analyze the data and the results compared to that of LICUR.

132. Bergman, L.R., & Wangby, M. The teenage girl: Patterns of self-reported adjustment problems and some correlates. *International Journal of Methods in Psychiatric Research* 5:171-188, 1995.

This article presents a pattern approach to the study of teenage girls' adjustment problems, analyzing data concerning 519 15-year-old girls included in the Swedish longitudinal research program, "Individual Development and Adjustment." The girls' profiles, as given by five self-reported adjustment problem indicators, are analyzed within a cluster analytic framework using the RESIDAN rationale, with due attention being paid to outliers and the importance of identifying a residue. Twelve clusters are identified. Some general features of the pattern approach are discussed.

133. Kaufman, L., & Rousseeuw, P.J. *Finding Groups in Data: An Introduction to Cluster Analysis*. New York: John Wiley & Sons, 1990.

This is an applied book on cluster analysis for general users or people who do not have a strong mathematical or statistical background. The first chapter of the book introduces the main approaches to clustering. Chapters 2 to 4 discuss partitioning methods. Chapters 5 to 7 cover hierarchical techniques.

134. Milligan, G.W. An examination of the effect of six types of error perturbation on fifteen clustering algorithms. *Psychometrika* 45(3):325-342, 1980.

An evaluation of several clustering methods was conducted. Artificial clusters that exhibited properties of internal coherence and external isolation were constructed. The true cluster structure was subsequently hidden by six types of error-perturbation. The results indicate that the hierarchical methods were differentially sensitive to the type of error perturbation. In addition, generally poor recovery performance was obtained when random seed points were used to start the K-means algorithms. However, two alternative starting procedures for the nonhierarchical methods produced greatly enhanced cluster recovery and were found to be robust with respect to all of the types of error examined.

135. Milligan, G.W. A review of Monte Carlo tests of cluster analysis. *Multivariate Behavioral Research* 16:379-407, 1981.

A review of Monte Carlo validation studies of clustering algorithms is presented. Several validation studies have tended to support the view that Ward's minimum variance hierarchical method gives the best recovery of cluster structure. However, a more complete review of the validation literature on clustering indicates that other algorithms may provide better recovery under a variety of conditions. Applied researchers are cautioned concerning the uncritical selection of Ward's method for empirical research. Alternative explanations for the differential recovery performance are explored, and recommendations are made for future Monte Carlo experiments.

7. Classification (Configural Frequency Analysis)

136. von Eye, A. Configural frequency analysis of longitudinal multivariate responses. In: von Eye, A., ed. *Statistical Methods in Longitudinal Research, Vol. II: Time Series and Categorical Longitudinal Data.* New York: Academic Press, 1990.

Configural frequency analysis (CFA) is a method of analyzing single cells in contingency tables, which are called configurations. CFA tests whether a configuration forms a type or an antitype. The chapter discusses methods for analysis of longitudinal multivariate responses with CFA. To tackle the problem of unmanageable numbers of contingency table cells in longitudinal categorical data, three methods of reducing the number of cells are discussed. The chapter gives data examples for each of these approaches.

8. Classification (Latent Class Analysis)

137. Clogg, C.C. Latent class models. In: Arminger, G., Clogg, C.C., & Sobel, M.E., eds. *Handbook of Statistical Modeling for the Social and Behavioral Sciences.* New York: Plenum Press, 1995, pp. 311-359.

The chapter reviews developments of latent class models (LCM) since the late 1970s, including the work by Goodman and Haberman. It includes mainly methodological or statistical references. The author refers to promising developments in the models, the methods, and the applications in the field. The chapter is a comprehensive and informative introduction to the topic.

138. Clogg, C.C., & Goodman, L.A. Latent structure analysis of a set of multidimensional contingency tables. *J Am Stat Assoc* 79:762-771, 1984.

The paper presents a general framework for simultaneous latent structure analysis of a set of two or more multidimensional contingency tables. The authors consider three basic types of models: (1) models that assume complete homogeneity across tables, (2) models that allow partial homogeneity across tables, and (3) models that allow complete heterogeneity. The authors then use two different sets of data to illustrate the procedures for model testing and parameter estimation.

139. Collins, L.M., Fidler, P.L., Wugalter, S.E., & Long, J.D. Goodness-of fit testing for latent class models. *Multivariate Behav Res* 28:375-389, 1993.

Latent class models with sparse contingency tables can present problems for model comparison and selection, because under these conditions the distributions of goodness-of-fit indices are often unknown. The authors present a simulation study to investigate the distributions of the likelihood ratio statistics G^2, the Pearson statistic X^2, and a new goodness-of-fit index suggested by Read and Cressie (1988). In general, the mean of the distribution of a statistic was closer to the expectation of the chi-squared distribution when the average cell expectation was large, there were fewer indicator items, and the latent class measurement parameters were less extreme. Based on the results they got, the authors argue that one solution to the problem of spare tables is to forego reliance on theoretical distributions for expectations and quantiles of goodness-of-fit statistics and to turn to empirical central or noncentral distributions obtained from Monte Carlo sampling procedures.

140. Collins, L.M., Graham, J.W., Long, J.D., & Hansen, W.B. Cross-validation of latent class models of early substance use onset. *Multivariate Behav Res* 29(2):165-183, 1994.

The purpose of this paper is to expand on Cudeck and Browne's (1983) work in two directions. The first direction of expansion is into testing of latent class models. The second direction of expansion involves using cross-validation to examine differences between groups, where groups may be formed by gender, ethnicity, region, etc. In this article cross-validation is used to help select models of early substance use onset in a sample of young adolescents. The result suggests that double cross-validation is preferred over single cross-validation.

141. Goodman, L.A. Exploratory latent structure analysis using both identifiable and unidentifiable models. *Biometrika* 61:215-231, 1974.

The paper considers a wide class of latent structure models, which serve as possible explanations of the observed relationships among a set of m manifest polytomous variables. The author considers both models that are identifiable and those that are not. For each of the models, the method is presented for calculating the maximum likelihood estimate of the expected frequencies and for determining whether the model is identifiable. In addition, the author discusses how to assess model fit and deal with unidentifiable models.

142. Haberman, S.J. *Qualitative Data Analysis. Vol. 2, New Developments*. New York: Academic Press, 1979.

Together with volume one of the series, the book provides a thorough introduction to linear models and to latent-class models. This volume explores models for qualitative data that go beyond the hierarchical log-linear models and logit models. Topics covered include multinomial response models, incomplete tables, symmetrical tables, adjustment of data, and latent-class models.

143. Langeheine, R., & Rost, J., eds. *Latent Trait and Latent Class Models*. New York: Plenum, 1988.

The edited volume presents a synthesis of latent trait and latent class models, which have been developed independently in different research areas and yet share a lot in common. An introductory chapter gives an overview of both types of models. In parts I and II of the book, there are papers that deal with specific topics in each of the models. Part III contains papers that compare the latent trait models to the latent class models. Part IV of the book describes applications of the two models to real data.

144. Lazarsfeld, P.F., & Henry, N.W. *Latent Structure Analysis*. Boston: Houghton Mifflin, 1968.

The book is a classic text on latent class modeling. It starts with a discussion of the concept of latent structure analysis and then deals with the mathematical aspects of the latent class models. Chapter 5 deals with the problem of ordered classes. Chapters 6 and 7 describe various latent structure models with continuous latent space, such as the latent content model and the polynomial traceline models. Chapters 8 and 9 discuss more general latent structure models: latent profile analysis and latent Markov chain models.

145. McCutcheon, A.C. *Latent Class Analysis*. Beverly Hills, CA: Sage Publications, 1987.

The text introduces the reader to latent class analysis, which enables a characterization of categorical latent variables from an analysis of the structure of the relationships among several

categorical manifest variables. The author first discusses the logic and application of the formal latent class model. He then describes exploratory and confirmatory applications of LCA. Chapter 4 covers the use of the latent class model for examining the scaling properties of a set of survey items. Chapter 5 is devoted to the use of LCA to model simultaneously the latent structure of two or more populations.

146. Rost, J. Rating scale analysis with latent class models. *Psychometrika* 53:327-348, 1988.

The article describes a general approach for analyzing rating data with latent class models. Previous rating scale analysis was associated with latent trait models. The author proposes a general model and a two-parameter model with location and dispersion parameters. The latter is analogous to Andrich's Disloc-model. Parameter estimation is done via EM-algorithm. The article contains two examples that illustrate the application of the models and their statistical control. Model restriction through equality constraints are discussed, and multiparameter generalizations are outlined.

B. Statistical Analyses for Longitudinal Data

1. General References

147. Collins, L.M., & Hom, J.L., eds. *Best Methods for the Analysis of Change: Recent Advances, Unanswered Questions, Future Directions*. Washington, DC: American Psychological Association, 1991.

The volume presents findings reported at an October 1989 conference entitled "Best Methods for the Analysis of Change" held at the University of Southern California. The major purpose of the conference was to identify significant problems of design an data analysis in research on change. The editors of the book organize chapters into the following themes: (1) Issues in Applied Settings—These chapters discuss methodological issues that have arisen in substantive applications; (2) Psychometric and Distributional Properties of Variables—These chapters address special problems presented by the measurement of change; (3) Design and Analysis—Chapters in this group explore important factors to consider in designing good studies to measure change and in analyzing data; (4) New Methodologies— This section includes latest developments in growth curve analysis, measurement methodologies, survival analysis, and time series analysis; and (5) Latent Variable Modeling—A number of chapters touch on various aspects of latent variable modeling.

148. Dwyer, J.H., Feinleib, M., Lippert, P., & Hoffmeister, H., eds. *Statistical Models for Longitudinal Studies of Health*. New York: Oxford University Press, 1992.

Most of the chapters in this volume are derived from papers presented at the Workshop on the Analysis of Longitudinal Data held in Berlin in 1987. The workshop tried to bring together statisticians from different health related fields that conduct longitudinal studies. It aimed to gain understanding of the fundamental statistical issues that confront longitudinal researchers in epidemiology and the social sciences. Part 1 deals with models for continuous variables. Part 2 examines models for categorical data. Part 3 deals with special problems in the modeling of longitudinal observations. Part 4 consists of two chapters that discuss future directions researchers can take in analyzing longitudinal data.

149. Gottman, J.M., ed. *The Analysis of Change*. Mahwah, NJ: Lawrence Erlbaum Associates, Inc., 1995.

As its title suggests, this edited volume deals with the latest developments in the study of change. It puts forward new ideas about how one would think about change and how it should be analyzed. The

book is divided into two sections. The first section deals with designs that analyze change in multiple subjects, and the second section deals with change in single subjects and an interacting system. Some topics covered in the book include myths about longitudinal research, hierarchical regression analysis, introduction to latent growth curve models, using hierarchical linear models to study contextual effects, survival analysis, accelerated short-term longitudinal design, autoregressive effects in structural equation models, sequential analysis, time-series analysis, and dynamic modeling.

150. Cohen, P. A source of bias in longitudinal investigations of change. In: Collins, L.M., & Hom, J.L., eds. *Best Methods for the Analysis of Change: Recent Advances, Unanswered Questions, Future Directions*. Washington, DC: American Psychological Association, 1991, pp. 18-30.

In this chapter, Cohen raises the problem of the "premature covariate," which arises when a covariate is changing over time. Cohen shows that, quite apart from any measurement error considerations, if a covariate is not measured at the time it exerts its causal influence, it may not be an effective covariate; that is statistical analysis may not partial out all of the effect of the covariate on the dependent variable.

151. von Eye, A., ed. *Statistical Methods in Longitudinal Research, Vol. I & II: Principals and Structuring Change*. New York: Academic Press, 1990.

The main goal of the two volumes of work is to narrow the gap between methodological advances in longitudinal investigation and the application of them in social sciences. The target audience of the work includes students of development and change. Each of the 16 chapters in the two volumes presents new aspects of methodology or statistics. Volume I contains sections 1 and 2, and volume II consists of sections 3 and 4. Section 1 covers problems of general interest in longitudinal research, such as the process of change, missing data, and approaches to repeated measurement analysis. Section 2 includes chapters on the structuring of change, longitudinal factor analysis, structural equation modeling, and methods of scaling. Section 3 covers the analysis of time series. It consists of chapters that discuss the use of event history analysis, spectral analysis, and "tukerizing curves." Section 4 discusses developments in the analysis of repeatedly observed categorical data. It includes chapters on the use of log-linear modeling, latent class analysis, and finite mixture distribution, and prediction analysis in contingency tables.

2. Analysis of Repeated Measurement Data

152. Davidian, M., & Giltinan, D.M. *Nonlinear Models for Repeated Measurement Data*. London: Chapman & Hall, 1995.

This book provides the first unified development of methods and models for data of this type, with a detailed treatment of inference for the nonlinear mixed effects model and its extensions. A practical strength of the book is the inclusion of several detailed case studies from the areas of population pharmacokinetics and pharmacodynamics, immunoassay and bioassay development, and the analysis of growth curves.

153. Greenhouse, S.W., & Geisser, S. On methods in analysis of profile data. *Psychometrika* 24:95-112, 1959.

This paper is concerned with methods for analyzing quantitative, noncategorical profile data, e.g. a battery of tests given to individuals in one or more groups. It is assumed that the variables have a

multinormal distribution with an arbitrary variance-covariance matrix. Approximate procedures based on classical analysis of variance are presented, including an adjustment to the degrees of freedom resulting in conservative F tests. These can be applied to the case where the variance-covariance matrices differ from group to group. In addition, exact generalized multivariate analysis methods are discussed.

154. Hand, D.J., & Crowder, M.J. *Practical Longitudinal Data Analysis*. London: Chapman and Hall, 1996.

A multitude of techniques are available for analyzing repeated measures data. The book describes the whole spectrum of approaches, beginning with very simple and crude methods, working through intermediate techniques commonly used by consultant statisticians, and concluding with more recent and advanced methods. Those cover multiple testing, response feature analysis, univariate analysis of variance approaches, multivariate analysis of variance approaches, regression models, two-stage linear models, approaches to categorical data, and techniques for analyzing crossover designs. The theory is illustrated with examples, using real data brought to the authors during their work as statistical consultants.

155. Hertzog, C., & Rovine, M. Repeated-measures analysis of variance in developmental research: selected issues. *Child Development* 56:787-809, 1985.

This paper presents a review of developments in statistical techniques for repeated-measures analysis of variance. The authors present an updated perspective on the nature of the mixed model assumptions and their implications for mixed model, adjusted mixed model, or multivariate significance test. However, the central theme of the review is that the validity of mixed model assumptions is but one consideration in selection of an appropriate method of repeated-measures ANOVA. In particular, the authors recommend the avoidance of omnibus significance tests in favor of specific planned comparisons whenever hypotheses more specific than the omnibus null hypothesis may be formulated a priori.

156. Lindsey, J.K. *Models for Repeated Measurement*. Oxford: Oxford University Press, 1995.

This book will be of interest to research statisticians in agriculture, medicine, economics, and psychology, and to the many consulting statisticians who want an up-to-date expository account of this important topic. The book is organized into four parts. In the first part, the general context of repeated measurements is presented. The three basic types of response variables—continuous (normal), categorical and count, and duration—are introduced. The ways in which such repeated observations are interdependent, through heterogeneity and time dependence, are discussed. A framework for constructing suitable models is developed, with the introduction of the necessary concepts of multivariate distributions and stochastic processes. In the following three parts, a large number of concrete examples, including data tables, are presented to illustrate the models available. Each of these parts corresponds to one to the types of responses mentioned above.

157. Rogan, J.C., Keselman, H.J., & Mendoza, J.L. Analysis of repeated measurements. *Br J Math Stat Psychol* 32:269-286, 1979.

The literature demonstrates that uniformity of population variances and covariances is a sufficient but not a necessary requirement for valid F ratios in repeated measures designs; the tests will be valid if the less restrictive condition of circularity is satisfied. The circularity assumptions of various repeated measures designs are presented, and the empirical literature is reviewed and interpreted in light of these assumptions. An empirical investigation is then presented, which compares numerous data analytic strategies when circularity assumptions have been violated. Results indicates that adjusted univariate and

multivariate tests are comparable with respect to type I error control and power. Furthermore, it is shown that by formulating planned comparisons researchers can bypass all or some circularity constraints.

158. Vonesh, E.F., & Chinchilli, V.M. *Linear and Nonlinear Models for the Analysis of Repeated Measurements*. New York: Marcel Dekker, Inc., 1997.

The book integrates the latest theory, methodology, and applications related to the design and analysis of repeated measurements–covering a broad range of topics including the analysis of repeated measures designs, general crossover designs, and linear and nonlinear regression models. The topics covered in the book include generalized multivariate analysis of variance, the random coefficient growth curve, and the linear mixed effects models, a nonlinear version of the generalized multivariate analysis of variance model, a Gaussian-based nonlinear mixed effects model, a generalized nonlinear mixed effects model, and generalized estimating equations for various estimating techniques.

3. General Estimating Equations (G.E.E.)

159. Diggle, P.J., Liang, K.-Y., & Zeger, S.L. *Analysis of Longitudinal Data.* Oxford: Oxford University Press, 1994.

This book describes statistical models and methods for the analysis of longitudinal data. It covers both the underlying statistical theory of each method and its application to a range of examples from the agricultural and biomedical sciences. Major topics in the book are design issues, exploratory methods of analysis, linear models for continuous data, general linear models for discrete data, and models and methods for handling data with missing values.

160. Liang, K.-Y., & Zeger, S.L. Longitudinal data analysis using generalized linear models. *Biometrika* 73:13-22, 1986.

This paper proposes an extension of generalized linear models to the analysis of longitudinal data. The authors introduce a class of estimating equations that give consistent estimates of the regression parameters and of their variance under mild assumptions about time dependence. The estimating equations are derived without specifying the joint distribution of a subject's observations yet they reduce to the score equations for multivariate Gaussian outcomes.

4. Latent Growth Curve Analysis

161. Bryk, A.S., & Raudenbush, S.W. Application of hierarchical linear model to assessing change. *Psychol Bull* 101(1):147-158, 1987.

The two authors use a two-stage model of change to model individual change. In the first stage, the within-subject stage, an individual's status on some trait is modeled as a function of an individual growth trajectory plus random error. At the second, or between-subjects stage, the parameters of the individual growth trajectories vary as a function of differences between subjects in background characteristics, instructional experiences, and possibly experimental treatments. The authors, using data on Head Start children, illustrate how this two-stage conceptualization allows investigators to model individual change, predict future development, assess the quality of measurement instruments for distinguishing among growth trajectories, and study systematic variation in growth trajectories as a function of background characteristics and experimental treatments.

162. Duncan, T.E., Duncan, S.C., Alpert, A., Hops, H., Stoolmiller, M., & Muthen, B. Latent variable modeling of longitudinal and multilevel substance use data. *Multivariate Behavioral Research* 32(3):275-318, 1997.

The authors of this article use the Multilevel Latent Growth Modeling (MLGM) approach, which is a latent variable growth analysis that takes into account cluster sampling, to analyze longitudinal and multilevel data for adolescent and parent substance use measured at four annual time points. The authors model the shape of the growth curve and the extent of individual differences in the common trajectory over time. The effects of marital and family status and socioeconomic status on family levels of substance use are also examined.

163. Francis, D.J., Fletcher, J.M., Stuebing, K.K., Davidson, K.C., & Thompson, N.M. Analysis of change: Modeling individual growth. *J Consult Clin Psychol* 59(1):27-37, 1991.

Research on change is complicated by problems of measurement and analysis stemming from a conceptualization of change as a series of accumulating increments and decrements. In contrast, individual growth curves depict change as a continuous process underlying individual performance. These two perspectives are reviewed, and some problems with the use of difference scores in the study of change are clarified. Traditional methods are contrasted with growth curve analysis for the purpose of measuring change and studying its correlates. An illustrative example of the use of growth curves is provided from research on recovery of cognitive function following pediatric closed head injury.

164. MacCallum, R.C., Kim, C., Malarkey, W.B., & Kiecolt-Glaser, J.K. Studying multivariate change using multilevel models and latent curve models. *Multivariate Behavioral Research* 32(3):215-253, 1997.

The paper proposes methods to study relationships between patterns of change on different variables. The authors show that multilevel modeling framework, which is often used to study univariate change, can be extended to the multivariate case to yield estimates of covariances of parameters representing aspects of change on different variables. The paper also considers extension of latent curve models to the multivariate case, and shows how such models are related to multivariate multilevel models.

165. McArdle, J.J., & Epstein, D. Latent growth curves within developmental structural equation models. *Child Development* 58:110-133, 1987.

The authors use structural equation modeling to combine ideas from repeated-measures ANOVA with ideas from longitudinal factor analysis, and present a longitudinal model that includes correlations, variances, and means. McArdle et al. name the approach latent growth curve model. They show that the technique permits the estimation of parameters representing both individual and group dynamics. Aspects of the latent growth models are illustrated with a set of longitudinal WISC data from young children.

166. Meredith, W., & Tisak, J. Latent curve analysis. *Psychometika* 55(1):107-122, 1990.

The authors describe the latent curve analysis, which contains individual parameters and a structure on both the first and second moments of the random variables reflecting growth. The paper also describes the ML estimation procedures and the asymptotic tests associated with the procedure. The authors also show the relationship between the procedure and standard repeated measures ANOVA as well as first-order-autoregressive methods. The latent curve analysis also encompasses cohort sequential designs and it allows for period or practice effects.

167. Rogosa, D.R., Brandt, D., & Zimowski, M. A growth curve approach to the measurement of change. *Psychol Bull* 92(3):726-748, 1982.

The authors approached the measurement of individual change from the standpoint of individual time paths and statistical models for individual change. The paper also considers both the psychometric properties of measures of individual change and examines measures of change for data with more than two observations on each individual. The author found that many of their results are at odds with previous literature in the behavioral sciences.

168. Rogosa, D.R., & Willet, J.B. Understanding correlates of change by modeling individual differences in growth. *Psychometrika* 50:203-228, 1985.

The paper proposes an approach to model systematic individual differences in growth. It consists of two parts: (1) a model for individual growth, and (2) a model for the dependence of parameters in the individual growth models on individual characteristics. The paper begins with explicit representations of correlates of change that are constructed for various models of individual growth. Then the authors discuss the special case of initial status as a correlate of change. Lastly, the shortcomings of previous approaches to the assessment of correlates of change are demonstrated. In particular, correlations of residual change measures with exogenous individual characteristics are shown to be poor indicators of systematic individual differences in growth.

169. Sayer, A.G., & Willet, J.B. A cross-domain model for growth in adolescent alcohol expectancies. *Multivariate Behav Res* 33:509-543, 1998.

The authors demonstrate how the methods of individual growth modeling and covariance structure analysis can be integrated and used to investigate the interrelationships among simultaneous individual changes in two domains—positive and negative alcohol expectancies—over the course of early to mid-adolescence, for both boys and girls. Sayer et al. represent individual change over time in positive expectancies with a piecewise growth model and in negative expectancies with a straight-line growth model. Then they use multisample covariance structure analysis to ask whether individual changes in positive and negative expectancies are related to each other and whether the pattern of interrelationships differs by gender.

170. Willett, J.B. Measuring change more effectively by modeling individual change over time. In: Husen, T., & Postlethwaite, T.N., eds. *The International Encyclopedia of Education,* 2nd ed. Oxford, England: Pergamon Press, 1994.

In this chapter Willett provides an overview about the various methods of measuring change in social sciences research. He first points out why change can be reasonably measured if one goes beyond the traditional "before and after," or "two wave," design. A discussion on the proper use of the difference score is also provided. Then the author shows how that can be done by fitting growth models to within-person changes and between-person differences in change.

171. Willett, J.B., Ayoub, C.C., & Robinson, D. Using growth modeling to examine systematic differences in growth: An example of change in the functioning of families at risk of maladaptive parenting, child abuse, or neglect. *J Consult Clin Psychol* 59(1):38-47, 1991.

This longitudinal study provides an example of the use of exploratory growth modeling to examine changes over time in the functioning of 172 families who underwent treatment in an innovative prevention program, Project Good Start. Two types of research question are addressed: a *within-family question* (Does family functioning change over time in families at risk of maltreatment who are receiving special early support services?) and a *between-family question* (Are changes in family functioning systematically related to selected characteristics of family background and treatment?). Results of the study highlight the heterogeneity across families in the direction and rate of family function change and its systematic relationship with the family profile on entry into intervention. Although treatment seems successful in stabilizing and improving the family functioning of most at-risk families, problems of violence/maltreatment, and distressed parenting act to defer successful treatment.

172. Willet, J.B., & Sayer, A.G. Using covariance structure analysis to detect correlates and predictors of individual change over time. *Psychol Bull* 116(2):363-381, 1994.

The article explains how the individual growth models can be reformatted to correspond to the measurement and structural components of the general LISREL model with mean structures and illustrates how the new method can be applied to a sample of longitudinal panel data. The integration of the two techniques brings the flexibility of covariance analysis into growth curve modeling.

5. Time Series Analysis

173. Aoki, M. *State Space Modeling of Time Series.* Berlin: Springer-Verlag, 1987.

In this book, the author adopts a state space approach to time series modeling to provide a new, computer-oriented method for building models for vector-valued time series. Background material leading up to the two types of estimators of the state space models is collected and presented coherently in four consecutive chapters. Expositions are given of conversion of ARMA models into state space forms, of properties of state space models, and how two alternative decompositions of Hankel matrices are used in constructing estimators. Later chapters explain in detail different types of innovation models.

174. Jones, R.H. *Longitudinal Data With Serial Correlation: A State-Space Approach*. London: Chapman & Hall, 1993.

The emphasis of the book is on methods for analyzing unbalanced repeated measures or longitudinal data with possible serial correlation. The basic model is a mixed fixed and random effects model often referred to as the Laird-Ware model. Both maximum likelihood and restricted maximum likelihood methods of estimation are discussed in detail in the book. Methods of model selection and the testing of contrasts of the fixed coefficients are discussed. The Kalman filter is presented as a method for calculating likelihoods for this class of models. The book also contains nonlinear models.

175. Lütkepohl, H. *Introduction to Multiple Time Series Analysis,* 2nd ed. New York: Springer-Verlag, 1993.

The book is based on the author's lecture notes in a course on multiple time series analysis for graduate students in business and economics. Chapters 1 to 4 contain an introduction to the vector

autoregressive methodology. Chapters 5 to 9 deal with mixed autoregressive moving average models. Chapter 10 reviews econometric dynamic simultaneous equations models; chapter 11 considers cointegration topic; chapter 12 discusses models with systematically varying coefficients, and chapter 13 describes the state space model.

176. McCleary, R., & Hay, R.A., Jr. *Applied Time Series Analysis for the Social Sciences*. Beverly Hills, CA: Sage Publications, 1980.

        The authors introduce the readers to univariate ARIMA models (emphasizing the Box-Jenkins iterative cycle of model identification, estimation, and diagnosis), impact assessments, and forecasts. This is followed by chapters on multivariate ARIMA models and ARIMA estimation algorithms.

177. Molenaar, P.C.M. A dynamic factor model for the analysis of multivariate time series. *Psychometrika* 50:181-202, 1985.

        To circumscribe the deficiency of the P-technique in handling lagged covariance structure, the author proposes a new statistical technique, the dynamic factor analysis. The technique accounts for the entire lagged covariance function of an arbitrary second order stationary time series. Besides, dynamic factor analysis is shown to be applicable to a relatively short stretch of observations, and the author suggests that it will be useful for a lot of psychological research.

178. Molenaar, P.C.M., De Gooijer, J.G., & Schmitz, B. Dynamic factor analysis of nonstationary multivariate time series. *Psychometrika* 57:333-349, 1992.

        The authors propose a dynamic factor model for the analysis of multivariate nonstationary time series in the time domain. The article deals with a mild form of nonstationarity often relevant in analyzing socioeconomic time series. Such nonstationarity in the series is represented by a linear time dependent mean function. By extending Molenaar's stationary dynamic factor analysis methods, the authors incorporate the effect of nonstationarity on the latent factor series, forming the dynamic nonstationary factor model (DNFM). The authors further demonstrate the properties of the DNFM model and its application.

179. Ostrom, C.W., Jr. *Time Series Analysis: Regression Techniques,* 2nd ed. Thousand Oaks, CA: Sage Publications, 1990.

        The monograph serves as an in-depth introduction to a variation of the basic regression model that utilizes data from time series. Ostrom shows how to diagnose the autocorrelation problem, starting with the simple first-order autoregression process and working up to higher order, moving average, and mixed error processes. Further, he spells out estimation procedures for overcoming autocorrelation difficulties. Several useful Generalized Least Squares approaches are discussed. The book also addresses important special topics: Box-Jenkins versus classical regression approaches; endogenous and exogenous lagged variables; and ex-post and ex-ante forecasting.

180. Rao, T.S. *Developments in Time Series Analysis: In Honour of Maurice B. Priestley*. London, Chapman & Hall, 1993.

        This volume contains 27 papers, written by well-known time series analysts, dealing with statistical theory, methodology and applications. The emphasis is on the recent developments in the analysis of linear, nonlinear (non-Gaussian), stationary and nonstationary time series. The topics include

cointegration, estimation and asymptotic theory, Kalman filtering, nonparametric statistical inference, long memory models, nonlinear models, and spectral analysis of stationary and nonstationary processes.

181. Shumway, R.H. *Applied Statistical Time Series Analysis*. New Jersey: Prentice Hall, 1988.

The book is an expanded version of lectures from a course in applied time series for graduate studies. Topics covered in the book include characteristics of time series, spectral analysis and filtering, time domain regression methods, frequency domain regression, pattern recognition and discriminant analysis, and time series computing.

182. Velicer, W.F., & McDonald, R.P. Cross-sectional time series designs: A general transformation approach. *Multivariate Behav Res* 26:247-254, 1991.

Cross-sectional time series designs assess the generalizability of intervention effects across different units. The article extends the general transformation approach proposed by the same authors in 1984 to the analysis of multiple unit data by the development of a patterned transformation matrix. A sequence of tests of the parameters permits the assessment of between-unit differences. The resulting procedure includes several alternative approaches as special cases and is easily implemented with only minor revisions in existing computer software.

6. Survival Analysis

183. Blossfeld, H.P., & Rohwer, G. *Event History Analysis: Statistical Theory and Application in the Social Sciences*. Mahwah, NJ: Lawrence Erlbaum Associates, 1995.

The book gives a comprehensive introductory account of event history modeling techniques and their usefulness for causal analysis in the social sciences. Besides, the volume deals with continuous-time models. It is both a student textbook and a reference book for research scientists. The book also introduces the reader to the Transition Data Analysis (TDA) program, which estimates the sorts of models most frequently used with longitudinal data, in particular, event history data.

184. Kalbfleisch, J.D., & Prentice, R.L. *The Statistical Analysis of Failure Time Data*. New York: Wiley, 1980.

The main purpose of the book is to collect and unify some statistical models and methods that have been proposed for analyzing failure time data. Special attention has been paid to problems arising in the biomedical sciences. Chapter 1 deals with the basic formulation of survival models and elementary methods of analysis. Chapter 2 presents common survival models for homogeneous populations. Chapter 3 deals with parameter estimation. The proportional hazards model is considered in chapter 4. Chapters 5 to 8 deal with more specialized topics.

185. Petersen, T. Analysis of event histories. In: Arminger, G., Clogg, C.C., & Sobel, M.E., eds. *A Handbook for Statistical Modeling in the Social and Behavioral Sciences*. New York: Plenum, 1992, pp. 453-517.

This chapter on event history analysis focuses on three types of failure-time or jump processes. The first is the single-state nonrepeatable event process, which is obtained when there is a single state that can be occupied only once. The second is the multistate process, in which the state currently occupied can be left for several distinct reasons. The third is the repeatable-event process. In such a

process, a person can occupy a state several times. In all three types of failure-time processes the objective of the empirical analysis is to analyze the determinants of the amount of time that elapses between changes and the value of the destination state once a change occurs. The chapter is organized into 17 sections, covering various topics in event history analysis, like various kinds of hazard-rate models, the influence of unobserved variables and time-aggregation bias, and how to deal with life censoring.

186. Singer, J.D., & Willett, J.B. Modeling the days of our lives: Using survival analysis when designing and analyzing studies of duration and the timing of events. *Psychol Bull* 110(2):268-290, 1991.

The article describes the use of survival analysis in answering psychological research questions, especially those that study whether and when events occur. One fundamental problem for such studies is the presence of censored observations. The article focuses on two aspects of survival analysis: study design and data analysis. It shows how psychologists have used the methods during the past decade and identifies new directions for future applications. Examples are drawn from research on mental health, addiction, social interaction, and the life course.

7. Latent Transition Analysis

187. Collins, L.M., Flaherty, B.P., Hyatt, S.L., & Schafer, J.L. *WinLTA User's Guide. Version 2.0.* The Methodology Center, The Pennsylvania State University, 1999.
(Available at http://methcenter.psu.edu/winlta/WinLTA.html)

The manual describes in detail how to fit latent transition models to data. I provide an overview of the mathematical model underlying LTA and the way parameters are estimated in the method. It also contains working examples that guide users in setting up LTA models.

188. Collins, L.M., Graham, J.W., Rousculp, S.C., & Hansen, W.B. Heavy caffeine use and the beginning of the substance use onset process: An illustration of latent transition analysis. In: Bryant, K.J., Windle, M., & West, S.G., eds. *The Science of Prevention: Methodological Advances from Alcohol and Substance Abuse Research*. Washington, DC: American Psychological Association, 1997.

The chapter introduces the readers to latent transition analysis (LTA) and demonstrates the usefulness of the technique in alcohol prevention research. The authors begin with a description of the LTA model, both in conceptual and statistical terms. Then they present the results of a study that use LTA to model the drug use of adolescents who participated in a survey conducted as part of the Adolescent Alcohol Prevention Trial (AAPT; Graham, Rohrbach, Hansen, Flay, & Johnson, 1989).

189. Collins, L.M., & Wugalter, S.E. Latent class models for stage-sequential dynamic latent variables. *Multivariate Behav Res* 27:131-157, 1992.

The authors presents the latent transition analysis (LTA) technique that can model stage-sequential dynamic latent variables in longitudinal studies. LTA expands the latent Markov model to allow applications to more complex latent variables and the use of multiple indicators. Because complex latent class models result in sparse contingency tables, which may lead to poor parameter estimation, a simulation study was conducted in order to determine whether model parameters are recovered adequately by LTA and whether additional indicators result in better measurement or in impossibly sparse tables. The results indicated that parameter recovery was satisfactory overall, although as expected the standard errors were large in some conditions with few subjects.

190. Graham, J.W., Collins, L.M., Wugalter, S.W., Chung, N.K., & Hansen, W.B. Modeling transitions in latent stage-sequential processes: A substance use prevention example. *J Consult Clin Psychol* 59:48-57, 1991.

This article illustrates the use of latent transition analysis (LTA), a methodology for testing stage-sequential models of individual growth. LTA is an outgrowth of latent class theory and is a particular type of latent Markov model emphasizing the use of multiple manifest indicators. LTA is used to compare the fit of two models of early adolescent substance use onset and to assess the effects of a school-based substance use prevention program on Ss measured in 7th grade and again in 8th grade.

V. SPECIAL TOPICS

A. Subject Attrition and Retention

191. Biglan, A., Hood, D., Brozovsky, P., Ochs, L., Ary, D., & Black, C. Subject attrition in prevention research. In: Leukefeld, C.G., & Bukoski, W.J., eds. *Drug Abuse Prevention Intervention Research: Methodological Issues. National Institute on Drug Abuse Research Monograph 107*. DHHS Pub. No. (ADM)91-1761. Washington, DC: Supt. of Docs., U.S. Govt. Print. Off., 1991, pp. 213-234.

The chapter discusses the role of subject attrition in substance abuse prevention research. Attrition may affect the validity of experimental comparisons and may limit the extent to which findings can be generalized to adolescents at highest risk. The authors examine concerns about subject attrition, present methods for analyzing attrition in evaluations of prevention programs, and make recommendations for minimizing the extent and impact of attrition in such evaluations.

192. Ellickson, P.L., Bianca, D., & Shoeff, D.C. Containing attrition in school-based research: An innovative approach. *Eval Rev* 12:331-351, 1988.

This article describes a successful approach for tracking a highly mobile group of junior high school transferees and thereby minimizing attrition in a longitudinal study of adolescent behavior. Students were tracked through the home or the new school. When students were located through the latter route, the authors sent the surveys directly to the school itself instead of asking for a home mailing address. This approach avoided asking school officials to give out personal information and enhanced the likelihood of the survey being delivered. Overall, the tracking effort cut nonresponse attributable to between-school mobility by two-thirds and reduced the attrition rate by one-half. The new-school strategy, which was a particularly effective technique for finding student transferees, accounted for a significant proportion of that improvement.

193. Hansen, W., Tobler, N., & Graham, J. Attrition in substance abuse prevention research: A meta-analysis of 85 longitudinally followed cohorts. *Eval Rev* 14(6):677-685, 1990.

This meta-analysis of substance abuse prevention studies reveals that the mean proportion of subjects retained dropped from 81.4 percent at 3-month followup to 67.5 percent at 3-year followup. Time from pretest alone accounted for less than 5 percent of the variance. Other available predictors of retention were not significant. Researchers are encouraged to interpret their results in light of these normative data and to adopt second-effort strategies to reduce attrition.

194. Willett, J.B., & Singer, J.D. From whether to when: New methods for studying student dropout and teacher attrition. *Rev Educ Res* 61(4):407-450, 1991.

The authors shows how the methods of survival analysis (also known as event history analysis) lend themselves naturally to the study of the timing of educational events. Drawing examples from the literature on teacher attrition and student dropout and graduation, the authors introduce a panoply of survival methods useful for describing the timing of educational transitions, e.g., student dropout and teacher attrition, and for building statistical models of the risk of event occurrence over time.

195. Streissguth, A.P., & Giunta, C.T. Subject recruitment and retention for longitudinal research: Practical considerations for a nonintervention model. In: Kilbey, M.M., & Asghar, K., eds. *Methodological Issues in Epidemiological, Prevention, and Treatment Research on Drug-Exposed Women and Their Children. National Institute on Drug Abuse Research Monograph 117*. DHHS Pub. No. (ADM)92-1881. Washington, DC: Supt. of Docs., U.S. Govt. Print. Off., 1992, pp. 137-154.

The chapter discusses strategies for subject recruitment and retention for longitudinal research. It examines issues that need to be considered in the planning of a study, factors that affect the success of the recruitment effort, and special techniques for tracing subjects and retaining subjects. It also discusses issues in staff recruitment, training, and inspiration, as well as budgeting.

B. Statistical Analysis with Missing Data

196. Allison, P.D. Estimation of linear models with incomplete data. In: Clogg, C., ed. *Sociological Methodology 1987*. San Francisco: Jossey-Bass, 1987, pp. 71-103.

The chapter describes the uses of ML to handle missing data problems in LISREL type of models. After describing the various missing data mechanisms first described by Rubin (1976), the author describes the assumptions underlying the method he proposed. The core of the paper describes how to use LISREL to get ML estimates of linear models with incomplete data. The method capitalizes on the ability of LISREL to estimate simultaneously the same model for two or more samples. For incomplete data problems, the sample is divided into subsamples, each having a different set of variables present. The model is then estimated simultaneously for all subsamples, constraining corresponding parameters to be equal across subsamples. The author further discusses the special techniques that are needed in such estimation. There is also an appendix that contains proofs.

197. Little, R.J.A., & Rubin, D.B. *Statistical Analysis With Missing Data*. New York: Wiley, 1987.

The book surveys methodology for handling missing-data problems and presents a likelihood-based theory for analysis with missing data that systematizes these methods. Part I of the book discusses ad hoc approaches to missing-value problems in three important areas of statistics: analysis of variance of planned experiments, survey sampling, and multivariate analysis. Part II presents a systematic approach to the analysis of data with missing values, where inferences are based on likelihoods derived from formal statistical models for the data and the missing-data mechanisms. Applications of the approach are presented in a variety of contexts, including regression, factor analysis, contingency table analysis, time series, and sample survey inference.

198. Little, R.J.A., & Schenker, N. Missing data. In: Arminger, G., Clogg, C.C., & Sobel, M.E., eds. *A Handbook for Statistical Modeling in the Social and Behavioral Sciences*. New York: Plenum, 1992, pp. 39-75.

In this chapter, Little and Schenker discuss modern methods for dealing with missing data. It covers important concepts underlying missing data procedures, differences between naive approaches, and more principled approaches. Then the chapter discusses various missing data procedures, such as weighting adjustment for unit nonresponse, maximum likelihood approaches, nonignorable nonresponse models, and multiple imputation. It also covers other Bayesian simulation methods.

199. Rindskopf, D. A general approach to categorical data analysis with missing data, using generalized linear models with composite links. *Psychometrika* 57:29-42, 1992.

Rindskopf describes a general approach for analyzing categorical data when there are missing data. The method is based on generalized linear models with composite links. The approach can be used (among other applications) to fill in contingency tables with supplementary margins. It is also used to fit log-linear models when data are missing, fit latent class models (without or with missing data on observed variables), fit models with fused cells, and fill in tables or fit models to data when variables are more finely categorized for some cases than others.

200. Rubin, D.B. Inference and missing data. *Biometrika* 63:581-592, 1976.

This is the classical paper written by Donald Rubin on the drawing of inferences about the parameter of the data when missing values are present. It reviews the previous statistical literature on missing data, and it provides a thorough theoretical discussion of the problem. The paper outlines the different kinds of missing data generating mechanisms and discusses the implication of each for making inference about the true value of parameters. The paper also discusses separately the use of direct-likelihood inferences and Bayesian inferences in the context of missing data.

201. Schafer, J.L. *Analysis of Incomplete Multivariate Data*. London: Chapman and Hall, 1997.

The book presents a unified, Bayesian approach to the analysis of incomplete multivariate data, covering data sets in which the variables are continuous, categorical, or both. It is written for applied statisticians, biostatisticians, practitioners of sample surveys, graduate students, and other methodologically oriented researchers in search of practical tools to handle missing data. The focus is applied rather than theoretical, but technical details is also included.

202. Clogg, C.C. Rubin, D.B., Schenker, D., Schultz, B., & Weidman, L. Multiple imputation of industry and occupation codes from Census public-use samples using Bayesian logistic regression. *J Am Stat Assoc* 86:68-78.

The authors describe methods used to create a new Census database that can be used to study comparability of industry and occupation classification systems. The project consists of extensive application of multiple imputation to data and the fitting of hundreds of logistic regression models. The paper summarize the strategies used in the project, and it shows how modifications of maximum likelihood methods were made for the modeling and imputation phases of the project. These methods include Bayesian methods that can deal with sparse data, which usually present problems for traditional ML methods.

203. Graham, J.W., & Schafer, J.L. On the performance of multiple imputation for multivariate data with small sample size. In: Hoyle, R., ed. *Statistical Strategies for Small Sample Research*. Thousand Oaks, CA: Sage Publications, 1999.

The purpose of the chapter is to investigate the performance of some of the latest missing-data technologies–in particular, multiple imputation using NORM–in realistic analyses where the sample size, *N*, is relatively small. The authors review from a user's perspective the key ideas of multiple imputation and the use of NORM software developed by Schafer (1997; NORM is available at http://methcenter.psu.edu/software.html). They then describe a simulation study designed to test the limits of NORM in a realistic setting where *N* is small and the data do not conform to assumptions of normality.

204. Schafer, J.L., & Olsen, M.K. Multiple imputation for multivariate missing-data problems: A data analyst's perspective. *Multivariate Behav Res* 33:545-571, 1998.

This article reviews the key ideas of multiple imputation, discusses the software programs currently available, and demonstrates their use on data from the Adolescent Alcohol Prevention Trial.

C. Selection of Covariates in Prevention/Epidemiological Studies

205. Baumrind, D. Familial antecedents of adolescent drug use: A developmental perspective. In: Jones, C.L., & Battjes, R.J., eds. *Etiology of Drug Abuse: Implications for Prevention. National Institute on Drug Abuse Research Monograph 56*. DHHS Pub. No. (ADM)87-1335. Washington, DC: Supt. of Docs., U.S. Govt. Print. Off, 1985, pp. 13-44.

The author considers the impact of early childhood and preadolescent socialization experiences on adolescent drug use from a developmental perspective. She first reviews the processes defining normal adolescent development and then presents findings on the preadolescent phase of the Family Socialization and Developmental Competence Project. The findings do not support the presupposition that adolescent drug use arises from pathological personal characteristics or pathogenic socialization practices. The study also found that the use of illegal drugs, such as marijuana, is not a deviant behavior for adolescents.

206. Donovan, J.E., & Jessor, R. Structure of problem behavior in adolescence and young adulthood. *J Consult Clin Psychol* 52(6):890-904, 1985.

The authors carried out a multivariate test of the existence of a single behavioral syndrome that comprises problem drinking, illicit drug use, delinquent-type behavior, and precocious sexual intercourse among normal adolescents. Analyses were conducted using maximum likelihood factor analyses based on self-report data from several samples of adolescents and youth who participated in the 1978 National Study of Adolescent Drinking (Rachal et al., 1980). Results of the study consistently showed that one common factor accounts for the correlations among the different problem behaviors. The authors argue that the findings lend support to the notion of a syndrome of problem behavior in both adolescence and young adulthood.

207. Greenspan, S.I. Research strategies to identify developmental vulnerabilities for drug abuse. In: Jones, C.L., & Battjes, R.J., eds. *Etiology of Drug Abuse: Implications for Prevention. National Institute on Drug Abuse Research Monograph 56.* DHHS Pub. No. (ADM) 85-1335. Washington, DC: Supt. of Docs., U.S. Govt. Print. Off., 1985, pp. 136-154.

     In this paper, Greenspan presents the developmental structuralist approach to etiologic and intervention research. Such an approach allows postulation of relationships between infancy and subsequent behaviors associated with drug use. The author later uses vignettes that illustrate how early intersensory integration, self-regulatory mechanisms, and affective development relate to subsequent impairments in affective relationships among individuals who develop antisocial behavior and substance use.

208. Hawkins, D.J., Catalano, R.F., & Miller, J.Y. Risk and protective factors for alcohol and other drug problems in adolescence and early adulthood. *Psychol Bull* 112(l):64-105, 1992.

     The authors propose that a risk-focused approach to prevention of adolescent alcohol and other drug problems is the most promising route to effective intervention strategies. Such an approach requires the identification of risk factors for drug abuse, identification of methods by which risk factors have been effectively addressed, and application of these methods to appropriate high-risk and general population samples in controlled studies. The authors review risk and protective factors to drug abuse, assess a number of approaches for drug prevention potential with high-risk groups, and make recommendations for research and practice.

209. Hawkins, J.D., Lishner, D.M., & Catalano, R.F., Jr. Childhood predictors and the prevention of adolescent substance abuse. In: Jones, C.L., and Battjes, R.J., eds. *Etiology of Drug Abuse: Implications for Prevention. National Institute on Drug Abuse Research Monograph 56*. DHHS Pub. No. (ADM)871335. Washington, DC: Supt. of Docs., U.S. Govt. Print. Off., 1985, pp. 75-126.

     The paper describes approaches to drug abuse prevention with preadolescent children. The authors review these approaches in light of the existing knowledge on the etiology of drug abuse among children and adolescents. They also identify gaps in the prevention intervention research and suggest etiological research that can aid in the development and refinement of preventive intervention focused on preadolescents.

210. Jessor, R. Bridging etiology and prevention in drug abuse research. In: Jones, C.L., & Battjes, R.J., eds. *Etiology of Drug Abuse: Implications for Prevention. National Institute on Drug Abuse Research Monograph 56*. DHHS Pub. No. (ADM) 85-1335. Washington, DC: Supt. of Docs., U.S. Govt. Print. Off., 1985.

     Jessor comments on four papers in the monograph that deal with the etiology of drug use during the transition from adolescents to young adulthood. He concludes by highlighting two major issues for drug abuse prevention research. The first is the appropriate goal for prevention. Rather than targeting at complete abstinence, he presents a more differentiated specification The author also discusses the implication of the findings on stages and sequences of drug initiation and the role early onset plays in drug use initiation for drug abuse prevention.

211. Johnston, L.D. Contributions of drug epidemiology to the field of drug abuse prevention. In: Leukefeld, C.G., & Brakoslu, W.J., eds. *Drug Abuse Prevention Research: Methodological Issues. National Institute on Drug Abuse Research Monograph 107*. DHHS Pub. No. (ADM) 91-1761. Washington, DC: Supt. of Docs., Govt. Print Off., 1991, pp. 57-80.

Johnston points out there are at least eight ways in which epidemiological studies could inform the development of drug prevention programs and the evaluations of such programs. He discusses each of them in detail in this book chapter. The eight areas are (1) drug use or drug-related problems that need to be prevented; (2) ages at which such use is initiated or problems are occurring; (3) subgroups in the population most "at risk" in terms of their demographic and lifestyle characteristics; (4) changing backdrop against which the effects of specific prevention efforts should be assessed; (5) importance of certain key intervening variables such as attitudes and beliefs; (6) behavioral and moral norms with regard to drug use among young people and other groups having influence on them; (7) extent to which major classes of prevention programming are reaching targeted segments of the population and the subjective opinions of those populations as to the helpfulness and effects of the interventions; and (8) combined effectiveness of all forces in the society that tend to reduce drug use or abuse, including those that are planned programs, more spontaneous efforts of groups or individuals, and other historical events.

212. Jones, C.L., & Battjes, R.J., eds. *Etiology of Drug Abuse: Implications for Prevention. National Institute on Drug Abuse Research Monograph 56*. DHHS Pub. No. (ADM)87-1335. Washington, DC: Supt. of Docs., U.S. Govt. Print. Off., 1985.

The monograph consists of a number of comprehensive review papers written by distinguished scientists in the field of etiological research on substance use. It focuses on results of etiologic research on adolescent drug use could be utilized to improve efforts to prevent drug abuse. The papers in the monograph are grouped into two section, the first one deal with antecedents to drug use during childhood and the impact of the transition to adolescence. The second part deals with risk factors that become prominent during the transition from adolescent to young adulthood.

213. Kandel, D.B., & Yamaguchi, K. Developmental patterns of the use of legal, illegal, and medically prescribed psychotropic drugs from adolescence to young adulthood. In: Jones, C.L., & Battjes, R.J., eds. *Etiology of Drug Abuse: Implications for Prevention. National Institute on Drug Abuse Research Monograph 56.* DHHS Pub. No. (ADM) 85-1335. Washington, DC: Supt. of Docs., U.S. Govt. Print. Off., 1985, pp. 193- 235.

Kandel and Yamaguchi present their findings on the developmental patterns of drug use among a cohort of young adults in a followup study during 1980-1981. Using the methodology of Guttman Scaling, they test specific sequential models of progression of drug use. Furthermore, using event history analysis, they try to answer the question of whether the use of certain drugs lower in the sequence influences the initiation of higher drugs. The authors then discuss their findings on the initiation of different types of illicit drugs.

214. Robins, L.N., & Przybeck, T.R. Age of onset of drug use as a factor in drug and other disorders. In: Jones, C.L., & Battjes, R.J., eds. *Etiology of Drug Abuse: Implications for Prevention. National Institute on Drug Abuse Research Monograph 56*. DHHS Pub. No. (ADM)87-1335. Washington, DC: Supt. of Docs., U.S. Govt. Print. Off., 1985, pp. 178-192.

The paper presents findings from a large-scale epidemiological study in three sites on drug disorder among adolescents. The high rate of drug disorder is related to rise in drug use in this population

but not to increase in vulnerability to addiction or abuse among users. Drug use disorders are associated with other psychopathology. Early onset of use predict increased risk of drug disorders and higher severity of the disorder. The findings suggest that a useful preventive strategy is to try to postpone first drug use to age 18 or later.

215. Shore, M.F. Correlates and concepts: Are we chasing our tails? In: Jones, C.L., & Battjes, R.J., eds. *Etiology of Drug Abuse: Implications for Prevention. National Institute on Drug Abuse Research Monograph 56*. DHHS Pub. No. (ADM)87-1335. Washington, DC: Supt. of Docs., U.S. Govt. Print. Off., 1985, pp. 127-135.

The paper is a response to three other papers in the monograph. The author first lists seven major advances in drug abuse research and then discusses the papers by Baumrind, Bush and Iannotti, and Hawkins, all of which focus on the impact of early childhood factors on later drug use. The author concludes by pointing out the difficulty in developing theories in prevention research, the challenges in developing useful research methodology for the field, and the need for longitudinal research paradigm.

D. Reducing Selection Bias and Adjusting for Initial Group Differences in Non-Randomized Treatment Studies

216. Berk, R.A. An introduction to sample selection bias, *American Sociological Review* 48:386-398, 1983.

This paper is a brief review of some of the methods in the diagnosis and correction for "sample selection bias." It describes, with the aid of diagram, the nature and consequence of sample selection bias. Drawing on Heckman's (1979) exposition of the problem, the author further explains the phenomenon in statistical terms. Later parts of the paper introduce the readers to several remedies to the problem.

217. Cochran, W.G. The effectiveness of adjustment by subclassification in removing bias in observational studies. *Biometrics* 24:295-313, 1968.

In the adjustment by subclassification method, the distribution of the covariate *x* is broken up into two, three, or more subclasses. For each group of subjects, the mean value of the response variable *y*, for the two groups under comparison, is calculated separately within each subclass. Then a weighted mean of these subclass means is calculated for each group, using the same weights for every group. The effectiveness of such a method in removing bias in observational studies was examined in this paper. The extent to which adjustment reduces the sampling error of the estimated difference between the *y* is also examined.

218. Cochran W.G., & Rubin, D.B. Controlling bias in observational studies: A review. *Snkhya, Series A* 35(4):417-446, 1973.

This paper reviews work on the effectiveness of different methods of matched sampling and statistical adjustment, alone and in combination, in reducing bias due to confounding *x*-variables when comparing two populations. The adjustment methods were linear regression adjustment for *x* continuous and direct standardization for *x* categorical. With *x* continuous, the range o situations examined included linear relations between *y* and *x*, parallel and nonparallel, monotonic nonlinear parallel relations, equal and unequal variances of *x*, and the presence of errors of measurement in *x*. The percent of initial bias that was removed was used as the criterion. Overall, linear regression adjustment on matched samples

appeared superior to the matching methods, with linear regression adjustment on matched samples the most robust method. Several different approaches are suggested for the case of multivariate *x*.

219. McKinlay, S.M. The effect of bias on estimators of relative risk for pair-matched and stratified samples. *J Am Stat Assoc* 70(352):859-864, 1977.

The author uses Monte Carlo methods to compare the effectiveness of pair-matched and independent stratified samples for estimating relative risk in the presence of bias. Three approximations to the maximum likelihood estimator for stratified samples suggested by Woolf, Mantel and Haenszel and Birch, respectively, are also compared. The results showed that the mean square error is always largest for the matched-pairs estimator, while of the stratified estimators, Woolf's consistently produces the smallest MSE, equaled by Birch's when the samples are equal.

220. Rosenbaum P.R., & Rubin, D.B. Reducing bias in observational studies using subclassification on the propensity score. *J Am Stat Assoc* 79(387):516-524, 1984.

The propensity score is the conditional probability of assignment to a particular treatment given a vector of observed covariates. It has been shown that subclassification on the propensity score will balance all observed covariates. The paper shows how the approach works using observational data on treatments for coronary artery disease. Subclasses are first defined by the estimated propensity score. These subclasses are applied within subpopulations, and model-based adjustments are then used to provide estimates of treatment effects within these subpopulation.

221. Rosenbaum, P.R., & Rubin, D.B. The central role of the propensity score in observational studies for causal effects. *Biometrika* 70(1):41-55, 1983.

Both large and small sample theory show that adjustment for the scalar propensity score is sufficient to remove bias due to all observed covariates in observational studies. The authors show that the approach can have the following applications: (1) matched sampling on the univariate propensity score, which is a generalization of discriminant matching, (2) multivariate adjustment by subclassification on the propensity score where the same subclasses are used to estimate treatment effects for all outcome variables and in all subpopulations, and (3) visual representation of multivariate covariance adjustment by a two-dimensional plot.

222. Rubin, D.B. Using multivariate matched sampling and regression adjustment to control bias in observational studies. *J Am Stat Assoc* 74(366):318-328, 1979.

Rubin studied the efficacy of multivariate matched sampling and regression adjustment for controlling bias due to specific matching variables *X* when dependent variables are moderately nonlinear in *X,* using Monte Carlo methods. The general conclusion he had is that nearest available Mahalanobis metric matching in combination with regression adjustment on matched pair differences is a highly effective plan for controlling bias due to *X.*

223. Rubin, D.B. Matching to remove bias in observational studies. *Biometrics* 29:159-183, 1973.

Several matching methods that match all of one sample from another larger sample on a continuous matching variable are compared with respect to their ability to remove the bias of the matching variable. One method is a simple mean-matching method, and three are nearest available pair-matching methods. The methods' abilities to remove bias are also compared with the theoretical

maximum given fixed distributions and fixed sample sizes. A summary of advice to an investigator is included.

224. Rubin, D.B. The use of matched sampling and regression adjustment to remove bias in observational studies. *Biometrics* 29:185-203, 1973.

The ability of matched sampling and linear regression adjustment to reduce the bias of an estimate of the treatment effect in two sample observational studies is investigated for a simple matching method and five simple estimates. Monte Carlo results are given for moderately linear exponential response surfaces, and analytic results are presented for quadratic response surfaces. One of the conclusions of the study is that the combination of regression adjustment in matched samples generally produces the least biased estimate.

225. Rubin, D.B. Multivariate matching methods that are equal percent bias reducing, I: some examples. *Biometrics* 32:109-120, 1976.

Multivariate matching methods are commonly used in the behavioral and medical sciences in an attempt to control bias when randomization is not feasible. Some examples of multivariate matching methods are discussed in Althauser and Rubin (1970) and Cochran and Rubin (1973) but otherwise have received little attention in the literature. The author presents examples of multivariate matching methods that will yield the same percent reduction in bias for each matching variable for a variety of underlying distribution. Eleven distributional cases are considered, and for each one, matching methods are described that are equal percent bias reducing.

226. Winship, C., & Mare, R.D. Models for sample selection bias. *Annu Rev Sociol* 18:327-350, 1992.

This chapter reviews models that attempt to take account of sample selection and their applications in research on labor markets, schooling, legal processes, social mobility, and social networks. Variants of these models apply to outcome variables that are censored or truncated–whether explicitly or incidentally–and include the tobit model, the standard selection model, models for treatment effects in quasi-experimental designs, and endogenous switching models. It also discusses Heckman's two-stage estimator.

E. Meta-Analysis

227. Bangert-Drowns, R.L. Review of developments in meta-analytic methods. *Psychol Bull* 99:388-399, 1986.

The author provides a brief history of the development of meta-analysis. The author also distinguishes five different approaches to meta-analytic method and makes suggestions for the use.

228. Bukoski, W.J., ed. *Meta-Analysis of Drug Abuse Prevention Programs. National Institute on Drug Abuse Research Monograph 170*. NTIS Pub. No. (ADM) 97-181598. Washington, DC: Supt. of Docs., U.S. Govt. Print. Off., 1997.

The monograph provides firsthand guidance in the application of research findings from meta-analysis and appropriate discussion of key technical procedures that should be considered in conducting future meta-analyses of drug abuse prevention research. It also helps to delineate what prevention programs and policies appear to be the most effective in combating drug abuse by adolescents and

young adults who may be entering the workplace. In the first section of the monograph, Tobler presents a meta-analysis of adolescent drug abuse prevention research findings; Schmidt and colleagues provide a meta-analysis of integrity tests for predicting drug and alcohol abuse; and Becker provides an approach for meta-analysis of drug-related risk and protective factors research. In the second section of the monograph, several chapters explore the appropriateness and special methodological considerations that must be addressed when conducting a meta-analysis of the drug abuse prevention research literature. Perry's chapter focuses upon methods to calculate effect sizes; Devine's chapter discusses issues in coding prevention intervention studies; Shadish and Heinsman assess the differences in outcomes produced by experimental versus quasi-experimental studies; Matt explores issues concerning generalized causal inferences related to program effects; Hansen reviews approaches to classifying independent variables and types of correlational relationships between dependent and independent variables; in separate chapters, Lipsey and Hedges discuss potential applications of meta-analysis for policy development; and Bangert-Drowns presents general advantages and potential limitations of conducting and utilizing meta-analysis in drug abuse prevention research. Collectively these chapters provide a current overview of the efficacy of drug abuse prevention programs and related measurement systems and help define the techniques employed in meta-analysis of drug abuse prevention programs.

229. Hedges, L.V., & Olkin, L. *Statistical Methods for Meta-Analysis*. Orlando, FL: Academic Press, 1985.

The main purpose of this book is to address the statistical issues for integrating independent studies through the method of meta-analysis. Chapter 3 of the book provides a review of omnibus procedures for testing the statistical significance of combined results. Later chapters discusses various methods to estimate and combine effect sizes. Chapters 7, 8, and 9 describe the different kinds of analysis that can be used to analyze and compare effect sizes. Chapters 10 and 11 explore the properties of correlated effect size estimates and their analysis. Chapter 12 deals with outliers, and chapter 13 discusses clustering procedures. Chapter 14 demonstrates the effects of censoring of effect size estimates corresponding to nonsignificant mean differences.

230. Hunter, J., & Schmidt, F. *Methods of Meta-Analysis: Correcting Error and Bias in Research Findings*. Newbury Park, CA: Sage Publications, 1990.

The authors present clear and detailed descriptions of meta-analysis methods, with extensive examples that clarify the applications of these methods. New methods for correcting statistical artifacts not previously addressed are presented for both correlational and experimental studies. Other features of the book include advances in artifact distribution-based meta-analysis methods and applications to examples, examination of the use of regression slopes and intercepts in meta-analysis, detailed treatment of repeated measures of experimental designs and meta-analysis methods for these designs, detailed treatment of second-order sampling error and its associated problems, exploration of the current and future role of meta-analysis in the social sciences, and extensive analysis of criticisms of meta-analysis.

231. Schmidt, F. What do data really mean? Research findings, meta-analysis, and cumulative knowledge in psychology. *Am Psychol* 47(10):1173-1181, 1992.

In this article, the author presents an introduction on the technology of meta-analysis. He first contrasts the approach with traditional methods and then describes the application of meta-analysis in industrial organizational psychology. Further, Schmidt outlines the role of meta-analysis in theory development and the broader impact it has on scientific research. The author argues that the broader dissemination of meta-analysis will lead to major changes in the way psychologists view the general research process.

232. Rosenthal, R., & Rubin, D.B. Comparing effect sizes of independent studies. *Psychol Bull* 92(2):500-504.

This article presents a general set of procedures for comparing the effect sizes of two or more independent studies. The procedures include a method for calculating the approximate significance level for the heterogeneity of effect sizes of studies and a method for calculating the approximate significance level of a contrast among the effect sizes. Although the focus is on effect size as measured by the standardized difference between the means (*d*) defined as $(M_1 - M_2)/S$, the procedures can be applied to any measure of effect size having an estimated variance. This extension is illustrated with effect size measured by the difference between proportions.

233. Strube, M.J., & Miller, R.H. Comparison of power rates for combined probability procedures: A simulation study. *Psychol Bull* 99(3):407-415, 1986.

Rosenthal (1978) presented a thorough description of six procedures for combining the significance levels from independent tests of the same conceptual hypothesis. This simulation study compares the power of these six methods. The results indicated that for large numbers of studies to be combined, all procedures provide comparable power. The techniques vary in their ease of computation, however, making some procedures more preferable under certain conditions.

F. Sample Size Calculation

234. Cohen, J. *Statistical Power Analysis for the Behavioral Sciences,* 2nd ed. Hillsdale, NJ: Erlbaum, 1990.

The book provides detailed a description of the concept of power analysis, and it is written as a handbook on the topics for behavioral researchers. It covers the power calculation for various statistical tests, t-test for means, significance of a product moment r, differences between correlation coefficients, the test that a proportion is .t and the sign test, differences between proportions, chi-square test, ANOVA and ANCOVA, multiple regression and correlation analysis, set correlation, and multivariate methods. The book concludes with chapters on issues in power analysis and some computational procedures.

235. Donner, A. Approaches to sample size estimation in the design of clinical trials: A review. *Stat Med* 3:199-214, 1984.

The paper reviews various methods of sample size estimation in the design of clinical trials. It is restricted to the discussion of designs with the primary purpose of comparing two groups of patients with respect to the occurrence of some specified event, such as death or the recurrence of disease. It takes into account the special nature of clinical trials that might preclude the direct applications of formal sample size planning and simple and straightforward formulae.

236. Kraemer, H.C., & Theimann, S. *How Many Subjects?* Beverly Hills, CA: Sage Publications, 1988.

The book treats power in a unified fashion across hypothesis testing techniques by calculating what the authors called critical effect size. It offers a simple introduction for nonstatisticians to power analysis and sample size determination as well as discussion on other topics like the conditions under which a repeated measures design will be more or less efficient than a cross-sectional design; the considerations involved in deciding whether to match or stratify subjects; the selection of variables for

multiple regression analysis; the value of equal (or near equal) N in analysis of variance designs; how to insure, in a correlational study, that the study will be valid; and the N required to make a reasonably rigorous test of one hypothesis using the chi-square technique.

237. Muller, K.E., LaVange, L.M., Ramey, S.L., & Ramey, C.T. Power calculations for general linear multivariate models including repeated measures applications. *J Am Stat Assoc* 87:1209-1226, 1992.

    The paper reviews recently developed methods for power analysis, in particular those applicable to general linear multivariate models (GLMM). The paper first discusses the motivation for using detailed power calculations, focusing on multivariate methods in particular. Second, the authors survey available methods for the general linear multivariate model (GLMM) with Gaussian errors and recommend those based on *F* approximations. The paper covers the multivariate and univariate approaches to repeated measures, MANOVA, ANOVA, multivariate regression, and univariate regression. Third, the authors describe the design of the power analysis for an example of a study that examines the impact of mothers' verbal IQ on children's intellectual development. Then the authors describe the result of their power analysis and evaluate the tradeoffs in using reduced designs and tests to simplify power calculations. Lastly, the authors discuss the benefits and costs of power analysis in the practice of statistics.

G. Human Subject Issues

238. Hoagwood K., Jensen, P.S., & Fisher, C.B. *Ethical Issues in Mental Health Research with Children and Adolescents*. Mahwah, NJ: LEA, 1996.

    The purpose of the book is to surface the key ethical dilemmas that investigators who study child and adolescent emotional, behavioral, developmental, and mental disorders are encountering, and to offer practical suggestions for integrating ethical thinking into such research. The book is organized into four parts. Part I introduces the major scientific, regulatory, and community principles that guide ethical practices in research on children's mental health. Part II reviews major ethical issues across diverse research contexts. Part II focuses attention on illustrative cases. Part IV discusses the role of bioethicists.

239. Porter, J.P. Regulatory considerations in research involving children and adolescents with mental disorders. In: Hoagwood, K., Jensen, P.S., & Fisher, C.B., eds. *Ethical Issues in Mental Health Research with Children and Adolescents*. Mahwah, NJ: LEA, 1996, pp. 15-28.

    The chapter highlights some of the regulatory considerations in the Department of Health and Human Services (DHHS) regulations for the protection of human subjects at Title 45 Code of Federal Regulations Part 46. These regulations provide the minimum standards for investigators. The author focuses on the regulatory aspects of research involving particularly vulnerable children.

240. Attkisson, C.C., Rosenblatt, A., & Hoagwood, K. Research ethics and human subjects protection in child mental health services research and community studies. In: Hoagwood, K., Jensen, P.S., & Fisher, C.B., eds. *Ethical Issues in Mental Health Research with Children and Adolescents*. Mahwah, NJ: LEA, 1996, pp. 43-58.

    The authors identify major ethical and human subject challenges encountered in conducting research on services for children and conducting research in communities more broadly, including epidemiological surveys. They also identify strategies used by researchers to overcome these obstacles.

241. Hibbs, E.D., & Krener, P. Ethical issues in psychosocial treatment research with children and adolescents. In: Hoagwood, K., Jensen, P.S., & Fisher, C.B., eds. *Ethical Issues in Mental Health Research with Children and Adolescents*. Mahwah, NJ: LEA, 1996, pp. 59-72.

In the chapter, the authors discuss five specific ethical issues that confront investigators who study the efficacy or effectiveness of psychosocial treatments for children. These issues are competence, informed consent/assent, confidentiality, use of incentives, and selection and involvement of control subjects.

242. Putnam, F.W., Liss, M.B., & Landsverk, J. Ethical issues in maltreatment research with children and adolescents. In: Hoagwood, K., Jensen, P.S., & Fisher, C.B., eds. *Ethical Issues in Mental Health Research with Children and Adolescents*. Mahwah, NJ: LEA, 1996, pp. 113-134.

This chapter addresses some of the complex ethical and legal dilemmas raised in research with maltreated and victimized children. In particular, the authors discuss the general legal and ethical principles for informed consent/assent with minors and the role of parents in consenting for their children to participate in research studies. They also enumerate common concerns raised by researchers and institutional review boards (IRBs) considering research protocols with maltreated children. The authors also mention the mechanism available for clarification of these problems.