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References

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Andrews: Inconsistency of the bootstrap when a parameter is on the boundary of the parameter space **Andrews-2000**

Donald W. K. Andrews. “Inconsistency of the bootstrap when a parameter is on the boundary of the parameter space”. In: *Econometrica* 68.2 (Mar. 2000), pp. 399–405. DOI: [10.1111/1468-0262.00114](https://doi.org/10.1111/1468-0262.00114).

Baker et al.: Addiction motivation reformulated: An affective processing model of negative reinforcement **Baker-Piper-McCarthy-et-al-2004**

Timothy B. Baker et al. “Addiction motivation reformulated: An affective processing model of negative reinforcement”. In: *Psychological Review* 111.1 (2004), pp. 33–51. ISSN: 0033-295X. DOI: [10.1037/0033-295x.111.1.33](https://doi.org/10.1037/0033-295x.111.1.33).

Abstract: This article offers a reformulation of the negative reinforcement model of drug addiction and proposes that the escape and avoidance of negative affect is the prepotent motive for addictive drug use. The authors posit that negative affect is the motivational core of the withdrawal syndrome and argue that, through repeated cycles of drug use and withdrawal, addicted organisms learn to detect interoceptive cues of negative affect preconsciously. Thus, the motivational basis of much drug use is opaque and tends not to reflect cognitive control. When either stressors or abstinence causes negative affect to grow and enter consciousness, increasing negative affect biases information processing in ways that promote renewed drug administration. After explicating their

model, the authors address previous critiques of negative reinforcement models in light of their reformulation and review predictions generated by their model.

Bauer et al.: Probing interactions in fixed and multilevel regression: Inferential and graphical techniques **Bauer-Curran-2005**

Daniel J. Bauer and Patrick J. Curran. “Probing interactions in fixed and multilevel regression: Inferential and graphical techniques”. In: *Multivariate Behavioral Research* 40.3 (July 2005), pp. 373–400. ISSN: 1532-7906. DOI: [10.1207/s15327906mbr4003_5](https://doi.org/10.1207/s15327906mbr4003_5).

Abstract: Many important research hypotheses concern conditional relations in which the effect of one predictor varies with the value of another. Such relations are commonly evaluated as multiplicative interactions and can be tested in both fixed- and random-effects regression. Often, these interactive effects must be further probed to fully explicate the nature of the conditional relation. The most common method for probing interactions is to test simple slopes at specific levels of the predictors. A more general method is the Johnson-Neyman (J-N) technique. This technique is not widely used, however, because it is currently limited to categorical by continuous interactions in fixed-effects regression and has yet to be extended to the broader class of random-effects regression models. The goal of our article is to generalize the J-N technique to allow for tests of a variety of interactions that arise in both fixed- and random-effects regression. We review existing methods for probing interactions, explicate the analytic expressions needed to expand these tests to a wider set of conditions, and demonstrate the advantages of the J-N technique relative to simple slopes with three empirical examples.

Bauer et al.: Conceptualizing and testing random indirect effects and moderated mediation in multilevel models: New procedures and recommendations

Bauer-Preacher-Gil-2006

Daniel J. Bauer, Kristopher J. Preacher, and Karen M. Gil. “Conceptualizing and testing random indirect effects and moderated mediation in multilevel models: New procedures and recommendations”. In: *Psychological Methods* 11.2 (2006), pp. 142–163. DOI: [10.1037/1082-989x.11.2.142](https://doi.org/10.1037/1082-989x.11.2.142).

Bentler: Can scientifically useful hypotheses be tested with correlations?

Bentler-2007

Peter M. Bentler. “Can scientifically useful hypotheses be tested with correlations?” In: *American Psychologist* 62.8 (2007), pp. 772–782. ISSN: 0003-066X. DOI: [10.1037/0003-066x.62.8.772](https://doi.org/10.1037/0003-066x.62.8.772).

Abstract: Historically, interesting psychological theories have been phrased in terms of correlation coefficients, which are standardized covariances, and various statistics derived from them. Methodological practice over the last 40 years, however, has suggested it is necessary to transform such theories into hypotheses on covariances and statistics derived from them. This complication turns out to be unnecessary, because the methodology now exists to test hypotheses on latent structures of correlations directly. Two examples are given. Limitations of correlation structures are also noted.

Beran: The impact of the bootstrap on statistical algorithms and theory **Beran-2003**

Rudolf Beran. “The impact of the bootstrap on statistical algorithms and theory”. In: *Statistical Science* 18.2 (May 2003). DOI: [10.1214/ss/1063994972](https://doi.org/10.1214/ss/1063994972).

Abstract: Bootstrap ideas yield remarkably effective algorithms for realizing certain programs in statistics. These include the construction of (possibly simultaneous) confidence sets and tests in classical models for which exact or asymptotic distribution theory is intractable. Success of the

bootstrap, in the sense of doing what is expected under a probability model for data, is not universal. Modifications to Efron's definition of the bootstrap are needed to make the idea work for modern procedures that are not classically regular.

Boker: Consequences of continuity: The hunt for intrinsic properties within parameters of dynamics in psychological processes **Boker-2002**

Steven M. Boker. "Consequences of continuity: The hunt for intrinsic properties within parameters of dynamics in psychological processes". In: *Multivariate Behavioral Research* 37.3 (July 2002), pp. 405–422. ISSN: 1532-7906. DOI: [10.1207/s15327906mbr3703_5](https://doi.org/10.1207/s15327906mbr3703_5).

Abstract: Notes that over 300 yrs ago Sir Isaac Newton wrote of a simple set of relations that could be used to predict the motions of objects relative to one another. The main advantage of this insight was that the relationship between the movements of the planets and stars could be predicted much more simply than with the accurate, but cumbersome Ptolemaic calculations. But perhaps the most important consequence of the acceptance of Newton's insight was that intrinsic properties such as mass could be distinguished from measurements such as weight. A similar revolution in thinking appears to be underway in the behavioral sciences. It is likely that intensive longitudinal measurement coupled with dynamical systems analyses will lead to simplified but powerful models of the evolution of psychological processes. In this case, it is reasonable to expect that a set of intrinsic psychological properties may be able to be extracted from the parameters of successful dynamical systems models. The purpose of this article is to issue an invitation to the hunt, to provide a tentative map as to where the game might likely be found, and blow a call on the hunting horn.

Bolger et al.: Diary methods: Capturing life as it is lived **Bolger-Davis-Rafaeli-2003**

Niall Bolger, Angelina Davis, and Eshkol Rafaeli. "Diary methods: Capturing life as it is lived".

In: *Annual Review of Psychology* 54.1 (Feb. 2003), pp. 579–616. ISSN: 1545-2085. DOI: [10.1146/annurev.psych.54.101601.145030](https://doi.org/10.1146/annurev.psych.54.101601.145030).

Abstract: In diary studies, people provide frequent reports on the events and experiences of their daily lives. These reports capture the particulars of experience in a way that is not possible using traditional designs. We review the types of research questions that diary methods are best equipped to answer, the main designs that can be used, current technology for obtaining diary reports, and appropriate data analysis strategies. Major recent developments include the use of electronic forms of data collection and multilevel models in data analysis. We identify several areas of research opportunities: 1. in technology, combining electronic diary reports with collateral measures such as ambulatory heart rate; 2. in measurement, switching from measures based on between-person differences to those based on within-person changes; and 3. in research questions, using diaries to (a) explain why people differ in variability rather than mean level, (b) study change processes during major events and transitions, and (c) study interpersonal processes using dyadic and group diary methods.

Boos: Introduction to the bootstrap world**Boos-2003**

Dennis D. Boos. “Introduction to the bootstrap world”. In: *Statistical Science* 18.2 (May 2003). DOI: [10.1214/ss/1063994971](https://doi.org/10.1214/ss/1063994971).

Abstract: The bootstrap has made a fundamental impact on how we carry out statistical inference in problems without analytic solutions. This fact is illustrated with examples and comments that emphasize the parametric bootstrap and hypothesis testing.

Casella: Introduction to the silver anniversary of the bootstrap**Casella-2003**

George Casella. “Introduction to the silver anniversary of the bootstrap”. In: *Statistical Science* 18.2 (May 2003). DOI: [10.1214/ss/1063994967](https://doi.org/10.1214/ss/1063994967).

Cheong et al.: Investigation of mediational processes using parallel process latent growth curve modeling
Cheong-MacKinnon-Khoo-2003

JeeWon Cheong, David P. MacKinnon, and Siek Toon Khoo. "Investigation of mediational processes using parallel process latent growth curve modeling". In: *Structural Equation Modeling: A Multidisciplinary Journal* 10.2 (Apr. 2003), pp. 238–262. DOI: [10.1207/s15328007sem1002_5](https://doi.org/10.1207/s15328007sem1002_5).

Abstract: This study investigated a method to evaluate mediational processes using latent growth curve modeling. The mediator and the outcome measured across multiple time points were viewed as 2 separate parallel processes. The mediational process was defined as the independent variable influencing the growth of the mediator, which, in turn, affected the growth of the outcome. To illustrate modeling procedures, empirical data from a longitudinal drug prevention program, Adolescents Training and Learning to Avoid Steroids, were used. The program effects on the growth of the mediator and the growth of the outcome were examined first in a 2-group structural equation model. The mediational process was then modeled and tested in a parallel process latent growth curve model by relating the prevention program condition, the growth rate factor of the mediator, and the growth rate factor of the outcome.

G. W. Cheung et al.: Testing mediation and suppression effects of latent variables
Cheung-Lau-2007

Gordon W. Cheung and Rebecca S. Lau. "Testing mediation and suppression effects of latent variables". In: *Organizational Research Methods* 11.2 (July 2007), pp. 296–325. DOI: [10.1177/1094428107300343](https://doi.org/10.1177/1094428107300343).

Abstract: Because of the importance of mediation studies, researchers have been continuously searching for the best statistical test for mediation effect. The approaches that have been most commonly employed include those that use zero-order and partial correlation, hierarchical regression models, and structural equation modeling (SEM). This study extends MacKinnon and colleagues (MacKinnon, Lockwood, Hoffmann, West, & Sheets, 2002; MacKinnon, Lockwood, & Williams,

2004, MacKinnon, Warsi, & Dwyer, 1995) works by conducting a simulation that examines the distribution of mediation and suppression effects of latent variables with SEM, and the properties of confidence intervals developed from eight different methods. Results show that SEM provides unbiased estimates of mediation and suppression effects, and that the bias-corrected bootstrap confidence intervals perform best in testing for mediation and suppression effects. Steps to implement the recommended procedures with Amos are presented.

M. W.-L. Cheung: Comparison of approaches to constructing confidence intervals for mediating effects using structural equation models **Cheung-2007**

Mike W.-L. Cheung. "Comparison of approaches to constructing confidence intervals for mediating effects using structural equation models". In: *Structural Equation Modeling: A Multidisciplinary Journal* 14.2 (May 2007), pp. 227–246. DOI: [10.1080/10705510709336745](https://doi.org/10.1080/10705510709336745).

Abstract: Mediators are variables that explain the association between an independent variable and a dependent variable. Structural equation modeling (SEM) is widely used to test models with mediating effects. This article illustrates how to construct confidence intervals (CIs) of the mediating effects for a variety of models in SEM. Specifically, mediating models with 1 mediator, 2 intermediate mediators, 2 specific mediators, and 1 mediator in 2 independent groups are illustrated. By using phantom variables (Rindskopf, 1984), a Wald CI, percentile bootstrap CI, bias-corrected bootstrap CI, and a likelihood-based CI on the mediating effect are easily constructed with some existing SEM packages, such as LISREL, Mplus, and Mx. Monte Carlo simulation studies are used to compare the coverage probabilities of these CIs. The results show that the coverage probabilities of these CIs are comparable when the mediating effect is large or when the sample size is large. However, when the mediating effect and the sample size are both small, the bootstrap CI and likelihood-based CI are preferred over the Wald CI. Extensions of this SEM approach for future research are discussed.

M. W.-L. Cheung: A model for integrating fixed-, random-, and mixed-effects meta-analyses into structural equation modeling. **Cheung-2008**

Mike W.-L. Cheung. "A model for integrating fixed-, random-, and mixed-effects meta-analyses into structural equation modeling." In: *Psychological Methods* 13.3 (2008), pp. 182–202. ISSN: 1082-989X. DOI: [10.1037/a0013163](https://doi.org/10.1037/a0013163).

Abstract: Meta-analysis and structural equation modeling (SEM) are two important statistical methods in the behavioral, social, and medical sciences. They are generally treated as two unrelated topics in the literature. The present article proposes a model to integrate fixed-, random-, and mixed-effects meta-analyses into the SEM framework. By applying an appropriate transformation on the data, studies in a meta-analysis can be analyzed as subjects in a structural equation model. This article also highlights some practical benefits of using the SEM approach to conduct a meta-analysis. Specifically, the SEM-based meta-analysis can be used to handle missing covariates, to quantify the heterogeneity of effect sizes, and to address the heterogeneity of effect sizes with mixture models. Examples are used to illustrate the equivalence between the conventional meta-analysis and the SEM-based meta-analysis. Future directions on and issues related to the SEM-based meta-analysis are discussed.

M. W.-L. Cheung: Comparison of methods for constructing confidence intervals of standardized indirect effects **Cheung-2009a**

Mike W.-L. Cheung. "Comparison of methods for constructing confidence intervals of standardized indirect effects". In: *Behavior Research Methods* 41.2 (May 2009), pp. 425–438. DOI: [10.3758/brm.41.2.425](https://doi.org/10.3758/brm.41.2.425).

Abstract: Mediation models are often used as a means to explain the psychological mechanisms between an independent and a dependent variable in the behavioral and social sciences. A major limitation of the unstandardized indirect effect calculated from raw scores is that it cannot be interpreted as an effect-size measure. In contrast, the standardized indirect effect calculated from

standardized scores can be a good candidate as a measure of effect size because it is scale invariant. In the present article, 11 methods for constructing the confidence intervals (CIs) of the standardized indirect effects were evaluated via a computer simulation. These included six Wald CIs, three bootstrap CIs, one likelihood-based CI, and the PRODCLIN CI. The results consistently showed that the percentile bootstrap, the bias-corrected bootstrap, and the likelihood-based approaches had the best coverage probability. Mplus, LISREL, and Mx syntax were included to facilitate the use of these preferred methods in applied settings. Future issues on the use of the standardized indirect effects are discussed.

M. W.-L. Cheung: Constructing approximate confidence intervals for parameters with structural equation models **Cheung-2009b**

Mike W.-L. Cheung. “Constructing approximate confidence intervals for parameters with structural equation models”. In: *Structural Equation Modeling: A Multidisciplinary Journal* 16.2 (Apr. 2009), pp. 267–294. DOI: [10.1080/10705510902751291](https://doi.org/10.1080/10705510902751291).

Abstract: Confidence intervals (CIs) for parameters are usually constructed based on the estimated standard errors. These are known as Wald CIs. This article argues that likelihood-based CIs (CIs based on likelihood ratio statistics) are often preferred to Wald CIs. It shows how the likelihood-based CIs and the Wald CIs for many statistics and psychometric indexes can be constructed with the use of phantom variables (Rindskopf, 1984) in some of the current structural equation modeling (SEM) packages. The procedures to form CIs for the differences in correlation coefficients, squared multiple correlations, indirect effects, coefficient alphas, and reliability estimates are illustrated. A simulation study on the Pearson correlation is used to demonstrate the advantages of the likelihood-based CI over the Wald CI. Issues arising from this SEM approach and extensions of this approach are discussed.

Sy-Miin Chow, Fumiaki Hamagani, and John R. Nesselroade. "Age differences in dynamical emotion-cognition linkages". In: *Psychology and Aging* 22.4 (Dec. 2007), pp. 765–780. ISSN: 0882-7974. DOI: [10.1037/0882-7974.22.4.765](https://doi.org/10.1037/0882-7974.22.4.765).

Abstract: The ability to maintain the separation between positive emotion and negative emotion in times of stress has been construed as a resilience mechanism. Emotional resiliency is particularly relevant in old age given concomitant declines in cognitive performance. In the present study, the authors examined the dynamical linkages among positive emotion, negative emotion, and cognition as individuals performed a complex cognitive task. Comparisons were made between younger ($n = 63$) and older ($n = 52$) age groups. Older adults manifested significant unidirectional coupling from negative emotion to cognitive performance; younger adults manifested significant unidirectional coupling from negative emotion to positive emotion and from cognitive performance to both positive and negative emotions. Implications for age differences in emotion regulatory strategies are discussed.

**Cole et al.: Empirical and conceptual problems with longitudinal trait-state models:
Introducing a trait-state-occasion model**

Cole-Martin-Steiger-2005

David A. Cole, Nina C. Martin, and James H. Steiger. "Empirical and conceptual problems with longitudinal trait-state models: Introducing a trait-state-occasion model". In: *Psychological Methods* 10.1 (Mar. 2005), pp. 3–20. ISSN: 1082-989X. DOI: [10.1037/1082-989x.10.1.3](https://doi.org/10.1037/1082-989x.10.1.3).

Abstract: The latent trait-state-error model (TSE) and the latent state-trait model with autoregression (LST-AR) represent creative structural equation methods for examining the longitudinal structure of psychological constructs. Application of these models has been somewhat limited by empirical or conceptual problems. In the present study, Monte Carlo analysis revealed that TSE

models tend to generate improper solutions when N is too small, when waves are too few, and when occasion factor stability is either too large or too small. Mathematical analysis of the LST-AR model revealed its limitation to constructs that become more highly auto-correlated over time. The trait-state-occasion model has fewer empirical problems than does the TSE model and is more broadly applicable than is the LST-AR model.

Cole et al.: Testing mediational models with longitudinal data: Questions and tips in the use of structural equation modeling. **Cole-Maxwell-2003**

David A. Cole and Scott E. Maxwell. "Testing mediational models with longitudinal data: Questions and tips in the use of structural equation modeling." In: *Journal of Abnormal Psychology* 112.4 (Nov. 2003), pp. 558–577. DOI: [10.1037/0021-843x.112.4.558](https://doi.org/10.1037/0021-843x.112.4.558).

Abstract: R. M. Baron and D. A. Kenny (1986; see record 1987-13085-001) provided clarion conceptual and methodological guidelines for testing mediational models with cross-sectional data. Graduating from cross-sectional to longitudinal designs enables researchers to make more rigorous inferences about the causal relations implied by such models. In this transition, misconceptions and erroneous assumptions are the norm. First, we describe some of the questions that arise (and misconceptions that sometimes emerge) in longitudinal tests of mediational models. We also provide a collection of tips for structural equation modeling (SEM) of mediational processes. Finally, we suggest a series of 5 steps when using SEM to test mediational processes in longitudinal designs: testing the measurement model, testing for added components, testing for omitted paths, testing the stationarity assumption, and estimating the mediational effects.

Cribari-Neto: Asymptotic inference under heteroskedasticity of unknown form **CribariNeto-2004**

Francisco Cribari-Neto. "Asymptotic inference under heteroskedasticity of unknown form". In:

Computational Statistics & Data Analysis 45.2 (Mar. 2004), pp. 215–233. DOI: [10.1016/S0167-9473\(02\)00366-3](https://doi.org/10.1016/S0167-9473(02)00366-3).

Abstract: We focus on the finite-sample behavior of heteroskedasticity-consistent covariance matrix estimators and associated quasi- t tests. The estimator most commonly used is that proposed by Halbert White. Its finite-sample behavior under both homoskedasticity and heteroskedasticity is analyzed using Monte Carlo methods. We also consider two other consistent estimators, namely: the HC3 estimator, which is an approximation to the jackknife estimator, and the weighted bootstrap estimator. Additionally, we evaluate the finite-sample behavior of two bootstrap quasi- t tests: the test based on a single bootstrapping scheme and the test based on a double, nested bootstrapping scheme. The latter is very computer-intensive, but proves to work well in small samples. Finally, we propose a new estimator, which we call HC4; it is tailored to take into account the effect of leverage points in the design matrix on associated quasi- t tests.

Cribari-Neto et al.: A new heteroskedasticity-consistent covariance matrix estimator for the linear regression model **CribariNeto-daSilva-2010**

Francisco Cribari-Neto and Wilton Bernardino da Silva. “A new heteroskedasticity-consistent covariance matrix estimator for the linear regression model”. In: *AStA Advances in Statistical Analysis* 95.2 (Nov. 2010), pp. 129–146. DOI: [10.1007/s10182-010-0141-2](https://doi.org/10.1007/s10182-010-0141-2).

Abstract: The assumption that all random errors in the linear regression model share the same variance (homoskedasticity) is often violated in practice. The ordinary least squares estimator of the vector of regression parameters remains unbiased, consistent and asymptotically normal under unequal error variances. Many practitioners then choose to base their inferences on such an estimator. The usual practice is to couple it with an asymptotically valid estimation of its covariance matrix, and then carry out hypothesis tests that are valid under heteroskedasticity of unknown form. We use numerical integration methods to compute the exact null distributions of some quasi-

t test statistics, and propose a new covariance matrix estimator. The numerical results favor testing inference based on the estimator we propose.

Cribari-Neto et al.: Inference under heteroskedasticity and leveraged data

CribariNeto-Souza-Vasconcellos-2007

Francisco Cribari-Neto, Tatiene C. Souza, and Klaus L. P. Vasconcellos. “Inference under heteroskedasticity and leveraged data”. In: *Communications in Statistics - Theory and Methods* 36.10 (Aug. 2007), pp. 1877–1888. DOI: [10.1080/03610920601126589](https://doi.org/10.1080/03610920601126589).

Abstract: We evaluate the finite-sample behavior of different heteroskedasticity-consistent covariance matrix estimators, under both constant and unequal error variances. We consider the estimator proposed by Halbert White (HC0), and also its variants known as HC2, HC3, and HC4; the latter was recently proposed by Cribari-Neto (2004). We propose a new covariance matrix estimator: HC5. It is the first consistent estimator to explicitly take into account the effect that the maximal leverage has on the associated inference. Our numerical results show that quasi- t inference based on HC5 is typically more reliable than inference based on other covariance matrix estimators.

Cribari-Neto et al.: Errata: Inference under heteroskedasticity and leveraged data, Communications in Statistics, Theory and Methods, 36, 1877–1888, 2007

CribariNeto-Souza-Vasconcellos-2008

Francisco Cribari-Neto, Tatiene C. Souza, and Klaus L. P. Vasconcellos. “Errata: Inference under heteroskedasticity and leveraged data, Communications in Statistics, Theory and Methods, 36, 1877–1888, 2007”. In: *Communications in Statistics - Theory and Methods* 37.20 (Sept. 2008), pp. 3329–3330. DOI: [10.1080/03610920802109210](https://doi.org/10.1080/03610920802109210).

Anthony Christopher Davison, David Victor Hinkley, and George Alastair Young. “Recent developments in bootstrap methodology”. In: *Statistical Science* 18.2 (May 2003). DOI: [10.1214/ss/1063994969](https://doi.org/10.1214/ss/1063994969).

Abstract: Ever since its introduction, the bootstrap has provided both a powerful set of solutions for practical statisticians, and a rich source of theoretical and methodological problems for statistics. In this article, some recent developments in bootstrap methodology are reviewed and discussed. After a brief introduction to the bootstrap, we consider the following topics at varying levels of detail: the use of bootstrapping for highly accurate parametric inference; theoretical properties of nonparametric bootstrapping with unequal probabilities; subsampling and the m out of n bootstrap; bootstrap failures and remedies for superefficient estimators; recent topics in significance testing; bootstrap improvements of unstable classifiers and resampling for dependent data. The treatment is telegraphic rather than exhaustive.

Bradley Efron. “Second thoughts on the bootstrap”. In: *Statistical Science* 18.2 (May 2003). DOI: [10.1214/ss/1063994968](https://doi.org/10.1214/ss/1063994968).

Abstract: This brief review article is appearing in the issue of Statistical Science that marks the 25th anniversary of the bootstrap. It concerns some of the theoretical and methodological aspects of the bootstrap and how they might influence future work in statistics.

Michael D. Ernst and Alan D. Hutson. “Utilizing a quantile function approach to obtain exact bootstrap solutions”. In: *Statistical Science* 18.2 (May 2003). DOI: [10.1214/ss/1063994978](https://doi.org/10.1214/ss/1063994978).

Abstract: The popularity of the bootstrap is due in part to its wide applicability and the ease of implementing resampling procedures on modern computers. But careful reading of Efron (1979) will show that at its heart, the bootstrap is a “plug-in” procedure that involves calculating a functional $\theta(\hat{F})$ from an estimate of the c.d.f. F . Resampling becomes invaluable when, as is often the case, $\theta(\hat{F})$ cannot be calculated explicitly. We discuss some situations where working with the sample quantile function, \hat{Q} , rather than \hat{F} , can lead to explicit (exact) solutions to $\theta(\hat{F})$.

Emilio Ferrer and John McArdle. “Alternative structural models for multivariate longitudinal data analysis”. In: *Structural Equation Modeling: A Multidisciplinary Journal* 10.4 (Oct. 2003), pp. 493–524. DOI: [10.1207/s15328007sem1004_1](https://doi.org/10.1207/s15328007sem1004_1).

Abstract: Structural equation models are presented as alternative models for examining longitudinal data. The models include (a) a cross-lagged regression model, (b) a factor model based on latent growth curves, and (c) a dynamic model based on latent difference scores. The illustrative data are on motivation and perceived competence of students during their first semester in high school. The 3 models yielded different results and such differences were discussed in terms of the conceptualization of change underlying each model. The last model was defended as the most reasonable for these data because it captured the dynamic interrelations between the examined constructs and, at the same time, identified potential growth in the variables.

Graham et al.: How many imputations are really needed? Some practical clarifications of multiple imputation theory **Graham-Olchowski-Gilreath-2007**

John W. Graham, Allison E. Olchowski, and Tamika D. Gilreath. “How many imputations are really needed? Some practical clarifications of multiple imputation theory”. In: *Prevention Science* 8.3 (June 2007), pp. 206–213. DOI: [10.1007/s11121-007-0070-9](https://doi.org/10.1007/s11121-007-0070-9).

Abstract: Multiple imputation (MI) and full information maximum likelihood (FIML) are the two most common approaches to missing data analysis. In theory, MI and FIML are equivalent when identical models are tested using the same variables, and when m , the number of imputations performed with MI, approaches infinity. However, it is important to know how many imputations are necessary before MI and FIML are sufficiently equivalent in ways that are important to prevention scientists. MI theory suggests that small values of m , even on the order of three to five imputations, yield excellent results. Previous guidelines for sufficient m are based on relative efficiency, which involves the fraction of missing information (γ) for the parameter being estimated, and m . In the present study, we used a Monte Carlo simulation to test MI models across several scenarios in which γ and m were varied. Standard errors and p -values for the regression coefficient of interest varied as a function of m , but not at the same rate as relative efficiency. Most importantly, statistical power for small effect sizes diminished as m became smaller, and the rate of this power falloff was much greater than predicted by changes in relative efficiency. Based our findings, we recommend that researchers using MI should perform many more imputations than previously considered sufficient. These recommendations are based on γ , and take into consideration one’s tolerance for a preventable power falloff (compared to FIML) due to using too few imputations.

Grundy et al.: Marital conflict and preadolescent behavioral competence: Maternal knowledge as a longitudinal mediator **Grundy-Gondoli-BlodgettSalafia-2007**

Amber M. Grundy, Dawn M. Gondoli, and Elizabeth H. Blodgett Salafia. “Marital conflict and preadolescent behavioral competence: Maternal knowledge as a longitudinal mediator”. In: *Journal*

of Family Psychology 21.4 (2007), pp. 675–682. ISSN: 0893-3200. DOI: [10.1037/0893-3200.21.4.675](https://doi.org/10.1037/0893-3200.21.4.675).

Abstract: The present study considered whether maternal knowledge mediated the relation between overt marital conflict and preadolescent behavioral competence. Four years of self-report data were collected from 133 mothers and their preadolescents, beginning when the preadolescents were in 4th grade. Marital conflict, maternal knowledge, and preadolescent behavioral competence were assessed at all 4 time points in order to apply a stringent methodology for assessing longitudinal mediating patterns. The results indicated that maternal knowledge mediated the relation between marital conflict and preadolescent behavioral competence. Thus, the present study identified one possible process through which marital conflict may affect preadolescent behavior.

Hall: A short prehistory of the bootstrap**Hall-2003**

Peter Hall. “A short prehistory of the bootstrap”. In: *Statistical Science* 18.2 (May 2003). DOI: [10.1214/ss/1063994970](https://doi.org/10.1214/ss/1063994970).

Abstract: The contemporary development of bootstrap methods, from the time of Efron’s early articles to the present day, is well documented and widely appreciated. Likewise, the relationship of bootstrap techniques to certain early work on permutation testing, the jackknife and cross-validation is well understood. Less known, however, are the connections of the bootstrap to research on survey sampling for spatial data in the first half of the last century or to work from the 1940s to the 1970s on subsampling and resampling. In a selective way, some of these early linkages will be explored, giving emphasis to developments with which the statistics community tends to be less familiar. Particular attention will be paid to the work of P. C. Mahalanobis, whose development in the 1930s and 1940s of moving-block sampling methods for spatial data has a range of interesting features, and to contributions of other scientists who, during the next 40 years, developed half-sampling, subsampling and resampling methods.

Hatemi-J: A new method to choose optimal lag order in stable and unstable VAR models **HatemiJ-2003**

Abdulnasser Hatemi-J. “A new method to choose optimal lag order in stable and unstable VAR models”. In: *Applied Economics Letters* 10.3 (Feb. 2003), pp. 135–137. DOI: [10.1080/1350485022000041050](https://doi.org/10.1080/1350485022000041050).

Abstract: A crucial aspect of empirical research based on the vector autoregressive (VAR) model is the choice of the lag order, since all inference in the VAR model is based on the chosen lag order. Here, a new information criterion is introduced for this purpose. The conducted Monte Carlo simulation experiments show that this new information criterion performs well in picking the true lag order in stable as well as unstable VAR models.

Hatemi-J: Multivariate tests for autocorrelation in the stable and unstable VAR models **HatemiJ-2004**

Abdulnasser Hatemi-J. “Multivariate tests for autocorrelation in the stable and unstable VAR models”. In: *Economic Modelling* 21.4 (July 2004), pp. 661–683. DOI: [10.1016/j.econmod.2003.09.005](https://doi.org/10.1016/j.econmod.2003.09.005).

Abstract: This study investigates the size and power properties of three multivariate tests for autocorrelation, namely portmanteau test, Lagrange multiplier (LM) test and Rao F-test, in the stable and unstable vector autoregressive (VAR) models, with and without autoregressive conditional heteroscedasticity (ARCH) using Monte Carlo experiments. Many combinations of parameters are used in the simulations to cover a wide range of situations in order to make the results more representative. The results of conducted simulations show that all three tests perform relatively well in stable VAR models without ARCH. In unstable VAR models the portmanteau test exhibits serious size distortions. LM and Rao tests perform well in unstable VAR models without ARCH. These results are true, irrespective of sample size or order of autocorrelation. Another clear result that the simulations show is that none of the tests have the correct size when ARCH is present irrespective of VAR models being stable or unstable and regardless of the sample size or order of autocorrelation.

The portmanteau test appears to have slightly better power properties than the LM test in almost all scenarios.

Hayes: Beyond Baron and Kenny: Statistical mediation analysis in the new millennium

Hayes-2009

Andrew F. Hayes. “Beyond Baron and Kenny: Statistical mediation analysis in the new millennium”. In: *Communication Monographs* 76.4 (Dec. 2009), pp. 408–420. DOI: [10.1080/03637750903310360](https://doi.org/10.1080/03637750903310360).

Abstract: Understanding communication processes is the goal of most communication researchers. Rarely are we satisfied merely ascertaining whether messages have an effect on some outcome of focus in a specific context. Instead, we seek to understand how such effects come to be. What kinds of causal sequences does exposure to a message initiate? What are the causal pathways through which a message exerts its effect? And what role does communication play in the transmission of the effects of other variables over time and space? Numerous communication models attempt to describe the mechanism through which messages or other communication-related variables transmit their effects or intervene between two other variables in a causal model. The communication literature is replete with tests of such models. Over the years, methods used to test such process models have grown in sophistication. An example includes the rise of structural equation modeling (SEM), which allows investigators to examine how well a process model that links some focal variable X to some outcome Y through one or more intervening pathways fits the observed data. Yet frequently, the analytical choices communication researchers make when testing intervening variables models are out of step with advances made in the statistical methods literature. My goal here is to update the field on some of these new advances. While at it, I challenge some conventional wisdom and nudge the field toward a more modern way of thinking about the analysis of intervening variable effects.

Hayes et al.: Using heteroskedasticity-consistent standard error estimators in OLS regression: An introduction and software implementation **Hayes-Cai-2007**

Andrew F. Hayes and Li Cai. “Using heteroskedasticity-consistent standard error estimators in OLS regression: An introduction and software implementation”. In: *Behavior Research Methods* 39.4 (Nov. 2007), pp. 709–722. DOI: [10.3758/bf03192961](https://doi.org/10.3758/bf03192961).

Holmes: Bootstrapping phylogenetic trees: Theory and methods **Holmes-2003a**

Susan Holmes. “Bootstrapping phylogenetic trees: Theory and methods”. In: *Statistical Science* 18.2 (May 2003). DOI: [10.1214/ss/1063994979](https://doi.org/10.1214/ss/1063994979).

Abstract: This is a survey of the use of the bootstrap in the area of systematic and evolutionary biology. I present the current usage by biologists of the bootstrap as a tool both for making inferences and for evaluating robustness, and propose a framework for thinking about these problems in terms of mathematical statistics.

Holmes: Bradley Efron: A conversation with good friends **Holmes-2003b**

Susan Holmes. “Bradley Efron: A conversation with good friends”. In: *Statistical Science* 18.2 (May 2003). DOI: [10.1214/ss/1063994981](https://doi.org/10.1214/ss/1063994981).

Abstract: Bradley Efron is Professor of Statistics and Biostatistics at Stanford University. He works on a combination of theoretical and applied topics, including empirical Bayes, survival analysis, exponential families, bootstrap and jackknife methods and confidence intervals. Most of his applied work has originated in biomedical consulting projects at the Stanford Medical School, mixed in with a few papers concerning astronomy and physics. Even his theoretical papers usually begin with specific applied problems. All three of the interviewers here have been close scientific collaborators. Brad was born in St. Paul, Minnesota, May 1938, to Esther and Miles Efron, Jewish-Russian immigrants. A Merit Scholarship, in the program’s inaugural year, brought him to Caltech, gradu-

ating in Mathematics in 1960. He arrived at Stanford that Fall, eventually gaining his Ph.D., under the direction of Rupert Miller and Herb Solomon, in the Statistics Department, whose faculty also included Charles Stein, Herman Chernoff, Manny Parzen, Lincoln Moses and Ingram Olkin. Brad has lived at Stanford since 1960, with sabbaticals at Harvard, Imperial College and Berkeley. He has held several administrative positions in the university: Chair of Statistics, Associate Dean of Science, Chairman of the University Advisory Board and Chair of the Faculty Senate. He is currently Chair of the Undergraduate Program in Applied Mathematics. Honors include doctorates from Chicago, Madrid and Oslo, a MacArthur Prize Fellowship, membership in the National Academy of Sciences and the American Academy of Arts and Sciences, fellowship in the IMS and ASA, the Wilks Medal, Parzen Prize, the newly inaugurated Rao Prize and the outstanding statistician award from the Chicago ASA chapter. He has been the Rietz, Wald, and Fisher lecturers and holds the Max H. Stein endowed chair as Professor of Humanities and Sciences at Stanford. Professional service includes Theory and Methods Editor of JASA and President of the IMS. Currently he is President-Elect of the American Statistical Association, becoming President in 2004.

Horowitz: The bootstrap in econometrics

Horowitz-2003

Joel L. Horowitz. "The bootstrap in econometrics". In: *Statistical Science* 18.2 (May 2003). DOI: [10.1214/ss/1063994976](https://doi.org/10.1214/ss/1063994976).

Abstract: This paper presents examples of problems in estimation and hypothesis testing that demonstrate the use and performance of the bootstrap in econometric settings. The examples are illustrated with two empirical applications. The paper concludes with a discussion of topics on which further research is needed.

Kauermann et al.: A note on the efficiency of sandwich covariance matrix estimation

Kauermann-Carroll-2001

Göran Kauermann and Raymond J. Carroll. "A note on the efficiency of sandwich covariance matrix

estimation”. In: *Journal of the American Statistical Association* 96.456 (Dec. 2001), pp. 1387–1396. DOI: [10.1198/016214501753382309](https://doi.org/10.1198/016214501753382309).

Abstract: The sandwich estimator, also known as robust covariance matrix estimator, heteroscedasticity-consistent covariance matrix estimate, or empirical covariance matrix estimator, has achieved increasing use in the econometric literature as well as with the growing popularity of generalized estimating equations. Its virtue is that it provides consistent estimates of the covariance matrix for parameter estimates even when the fitted parametric model fails to hold or is not even specified. Surprisingly though, there has been little discussion of properties of the sandwich method other than consistency. We investigate the sandwich estimator in quasi-likelihood models asymptotically, and in the linear case analytically. We show that under certain circumstances when the quasi-likelihood model is correct, the sandwich estimate is often far more variable than the usual parametric variance estimate. The increased variance is a fixed feature of the method and the price that one pays to obtain consistency even when the parametric model fails or when there is heteroscedasticity. We show that the additional variability directly affects the coverage probability of confidence intervals constructed from sandwich variance estimates. In fact, the use of sandwich variance estimates combined with t -distribution quantiles gives confidence intervals with coverage probability falling below the nominal value. We propose an adjustment to compensate for this fact.

Kenny et al.: Lower level mediation in multilevel models

Kenny-Korchmaros-Bolger-2003

David A. Kenny, Josephine D. Korchmaros, and Niall Bolger. “Lower level mediation in multilevel models”. In: *Psychological Methods* 8.2 (2003), pp. 115–128. ISSN: 1082-989X. DOI: [10.1037/1082-989x.8.2.115](https://doi.org/10.1037/1082-989x.8.2.115).

Abstract: Multilevel models are increasingly used to estimate models for hierarchical and repeated measures data. The authors discuss a model in which there is mediation at the lower level and the mediational links vary randomly across upper level units. One repeated measures example

is a case in which a person's daily stressors affect his or her coping efforts, which affect his or her mood, and both links vary randomly across persons. Where there is mediation at the lower level and the mediational links vary randomly across upper level units, the formulas for the indirect effect and its standard error must be modified to include the covariance between the random effects. Because no standard method can estimate such a model, the authors developed an ad hoc method that is illustrated with real and simulated data. Limitations of this method and characteristics of an ideal method are discussed.

Koob et al.: Addiction and the brain antireward system

Koob-LeMoal-2008

George F. Koob and Michel Le Moal. "Addiction and the brain antireward system". In: *Annual Review of Psychology* 59.1 (Jan. 2008), pp. 29–53. ISSN: 1545-2085. DOI: [10.1146/annurev.psych.59.103006.093548](https://doi.org/10.1146/annurev.psych.59.103006.093548).

Abstract: A neurobiological model of the brain emotional systems has been proposed to explain the persistent changes in motivation that are associated with vulnerability to relapse in addiction, and this model may generalize to other psychopathology associated with dysregulated motivational systems. In this framework, addiction is conceptualized as a cycle of decreased function of brain reward systems and recruitment of antireward systems that progressively worsen, resulting in the compulsive use of drugs. Counteradaptive processes, such as opponent process, that are part of the normal homeostatic limitation of reward function fail to return within the normal homeostatic range and are hypothesized to repeatedly drive the allostatic state. Excessive drug taking thus results in not only the short-term amelioration of the reward deficit but also suppression of the antireward system. However, in the long term, there is worsening of the underlying neurochemical dysregulations that ultimately form an allostatic state (decreased dopamine and opioid peptide function, increased corticotropin-releasing factor activity). This allostatic state is hypothesized to be reflected in a chronic deviation of reward set point that is fueled not only by dysregulation of reward circuits per se but also by recruitment of brain and hormonal stress responses. Vulnerability

to addiction may involve genetic comorbidity and developmental factors at the molecular, cellular, or neurocircuitry levels that sensitize the brain antireward systems.

Krull et al.: Multilevel modeling of individual and group level mediated effects

Krull-MacKinnon-2001

Jennifer L. Krull and David P. MacKinnon. “Multilevel modeling of individual and group level mediated effects”. In: *Multivariate Behavioral Research* 36.2 (Apr. 2001), pp. 249–277. ISSN: 1532-7906. DOI: [10.1207/s15327906mbr3602_06](https://doi.org/10.1207/s15327906mbr3602_06).

Abstract: This article combines procedures for single-level mediational analysis with multilevel modeling techniques in order to appropriately test mediational effects in clustered data. A simulation study compared the performance of these multilevel mediational models with that of single-level mediational models in clustered data with individual- or group-level initial independent variables, individual- or group-level mediators, and individual level outcomes. The standard errors of mediated effects from the multilevel solution were generally accurate, while those from the single-level procedure were downwardly biased, often by 20% or more. The multilevel advantage was greatest in those situations involving group-level variables, larger group sizes, and higher intraclass correlations in mediator and outcome variables. Multilevel mediational modeling methods were also applied to data from a preventive intervention designed to reduce intentions to use steroids among players on high school football teams. This example illustrates differences between single-level and multilevel mediational modeling in real-world clustered data and shows how the multilevel technique may lead to more accurate results.

Lahiri: On the impact of bootstrap in survey sampling and small-area estimation

Lahiri-2003

Partha Lahiri. “On the impact of bootstrap in survey sampling and small-area estimation”. In: *Statistical Science* 18.2 (May 2003). DOI: [10.1214/ss/1063994975](https://doi.org/10.1214/ss/1063994975).

Abstract: Development of valid bootstrap procedures has been a challenging problem for survey samplers for the last two decades. This is due to the fact that in surveys we constantly face various complex issues such as complex correlation structure induced by the survey design, weighting, imputation, small-area estimation, among others. In this paper, we critically review various bootstrap methods developed to deal with these challenging issues. We discuss two applications where the bootstrap has been found to be effective.

Lele: Impact of bootstrap on the estimating functions

Lele-2003

Subhash R. Lele. “Impact of bootstrap on the estimating functions”. In: *Statistical Science* 18.2 (May 2003). DOI: [10.1214/ss/1063994973](https://doi.org/10.1214/ss/1063994973).

Abstract: Estimating functions form an attractive statistical methodology because of their dependence on only a few features of the underlying probabilistic structure. They also put a premium on developing methods that obtain model-robust confidence intervals. Bootstrap and jackknife ideas can be fruitfully used toward this purpose. Another important area in which bootstrap has proved its use is in the context of detecting the problem of multiple roots and searching for the consistent root of an estimating function. In this article, I review, compare and contrast various approaches for bootstrapping estimating functions.

Long et al.: Using heteroscedasticity consistent standard errors in the linear regression model

Long-Ervin-2000

J. Scott Long and Laurie H. Ervin. “Using heteroscedasticity consistent standard errors in the linear regression model”. In: *The American Statistician* 54.3 (Aug. 2000), pp. 217–224. DOI: [10.1080/00031305.2000.10474549](https://doi.org/10.1080/00031305.2000.10474549).