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McCall R B & Appelbaum M I. Bias in the analysis of repeated-measures designs: some alternative approaches. *Child Develop.* 44:401-15, 1973.

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This paper reports that the commonly used repeated-measures analysis of variance makes important assumptions regarding the variance-covariance structure of the data (e.g., correlations among repeated measures) that are often not met. Violations of these assumptions bias the analysis toward rejecting the null hypothesis. Several alternative approaches to analyzing such data are presented from an applied rather than a theoretical standpoint, and multivariate techniques that make no covariance assumptions and provide exact probability statements are featured. [The *Science Citation Index*[®] (SCI[®]) and the *Social Sciences Citation Index*[®] (SSCI[®]) indicate that this paper has been cited in over 170 publications, making it the most-cited paper published in this journal since 1973.]

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Every behavioral researcher needs a friend in the applied statistics business. Mine was Mark Appelbaum. Mark taught me that if the pair-wise correlations among repeated measures were not homogeneous (i.e., the assumption of compound symmetry was violated), traditional methods of analyzing repeated-measures analysis-of-variance designs were biased toward rejecting the null hypothesis. While all the statisticians I knew seemed to recognize this problem, none of my colleagues in developmental research was aware of this bias.

Why this gap? No one had told the researchers there was a problem. Most of my research colleagues took statistics before this issue was widely taught.

Well, then, someone ought to tell them. But the "someone" should be one who could communicate with researchers, and the "telling" should be in an applied rather than in a theoretical style. So I asked Mark to provide me with the statistical information on the nature of the problem and the advantages and disadvantages, both practical and statistical, of various alternative strategies. Then I wrote an article that attempted to state this material in relatively nontechnical terms and to illustrate, complete with numerical examples, the computation and the

interpretation of each approach. The paper was similar in style to a section from an applied statistics text.

Getting it published, however, was not easy. I wanted it to appear where researchers, especially developmentalists, who were most likely to use such designs, would read it. Reviewers scratched their heads about the appropriateness of such an article for *Child Development*. But the editor, Wendell Jeffrey of UCLA, was encouraging and published it as a lead review article.

Reaction was immediate. Some people asked, "You mean I have been analyzing my data wrong all these years?" Similarly, the editor of another leading journal in developmental psychology wrote to ask whether he should make an editorial policy that all repeated-measures designs be analyzed by the alternative methods recommended in our paper.

The popularity of the paper is not because it made a new contribution to knowledge—nothing stated in it was statistically new. Rather, it filled a knowledge gap between statisticians and researchers, and it communicated the problem and the solution to researchers in a nontechnical, here's-why-and-how-you-do-it style. It was a timely continuing-education article. I also suspect that its influence led to the invitation to Mark and me to write a comprehensive chapter on design and analysis for the recent *Handbook of Child Psychology*.¹

I hope this case study demonstrates to editors of content journals that not everything they publish needs to be an original empirical or theoretical article. Fields can be moved forward by continuing-education papers that are styled to be useful and understandable to their readership. Similarly, journals having primarily an applied audience might occasionally encourage articles by researchers that review knowledge in a scientific or scholarly domain that might be useful to practitioners. Also, editors in one discipline might encourage review articles from scholars in other disciplines on topics that cut across disciplinary lines. Let us admit that we cannot keep pace with developments in all disciplines or levels of knowledge, and that most of us simply do not read in disciplines or areas other than our specialties. Therefore, we need articles that update our knowledge published in journals that we are likely to read.

1. Appelbaum M I & McCall R B. Design and analysis in developmental psychology. (Kessen W, ed.) *Handbook of child psychology. Volume 1. History, theory, and methods.* New York: Wiley, 1983. p. 415-76.