

Analyzing Data with Missing Values from a Split-Plot Design: A Mixed-Model Approach Using the Kenward-Roger Adjusted Degree of Freedom Omnibus Test

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Abstract:

Split-plot designs, characterized by having both between- and within-subjects factors, are popular designs in educational and psychological research. Additionally, data collected through such designs are often incomplete in that participants often have one or more missing values on the within-subjects factor. One promising technique, when data are missing, is to use maximum likelihood (ML) to directly estimate the model parameters and the sampling covariance matrix of the estimates and use these estimated quantities to test hypotheses. These techniques are implemented in PROC MIXED, a general mixed-model procedure in SAS, and are therefore widely available. It has been shown that the Kenward-Roger (KR) adjusted degree of freedom omnibus test statistic in PROC MIXED performs well at controlling the Type I error in a one factor within-subjects design under missing completely (MCAR) and missing at random (MAR) missing data mechanisms. Additionally, it has been demonstrated that the KR test performs well at controlling Type I error in unbalanced split-plot and similar designs, but its performance has not been assessed under MCAR and MAR missing data mechanisms in split-plot designs. This study assessed the performance of the KR test at controlling the Type I error under MCAR and MAR missing data mechanisms in a split-plot design with one between- and one within-subjects factor. The results indicate that the KR test controlled the Type I error rate well under all of the factors of the simulation study. Additionally, a real data set with missing values is used to demonstrate how the split-plot design may be analyzed through a hierarchical linear modeling framework using the KR test.