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The impact of baseline trend control on visual analysis of single-case data

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ABSTRACT

The impact of baseline trend control on visual analyses of AB intervention graphs was examined with simulated data at various values of baseline trend, autocorrelation, and effect size. Participants included 202 undergraduate students with minimal training in visual analysis and 10 graduate students and faculty with more training and experience in visual analysis. In general, results were similar across both groups of participants. Without statistical adjustments to correct for baseline trend, Type I errors greatly increased as baseline trend increased. With corrections for baseline trend, fewer Type I errors were made. As trend increased, participants made fewer Type II errors on the unadjusted graphs as compared to the graphs with baseline trend control. The greater Type II error rate on adjusted graphs could be an artifact of study design (i.e., participants did not know if baseline trend control had been applied), and the impact of MASAJ on Type II errors needs to be explored in detail prior to more widespread use of the method. Implications for future use of baseline trend control techniques by educational professionals are discussed.

1. Introduction

Evaluating the effectiveness of interventions for individual students is a critical feature of response to intervention (RTI) models of service delivery; accordingly, skill in single-case design and analysis (SCD) is increasingly important for school psychologists and other education professionals (Riley-Tillman & Burns, 2009). Despite the importance of SCD in educational settings, few pre-service teachers report having taken

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coursework in graphing of data, single-case design, or making decisions on graphed intervention data (Begeny & Martens, 2006). In addition, school psychologists often have few practicum experiences in the areas of applied behavior analysis or behavioral consultation in which skills in SCD are often developed (Shriver & Watson, 1999), and many school psychology programs do not offer or require coursework in SCD. For these reasons, research on methods to train education professionals to improve accuracy of judgments by individuals with less experience in SCD will be critical to support more widespread implementation of RTI.

1.1. Errors in Visual Analysis

Visual analysis of graphed behavioral data is the primary inferential method in single-case behavioral research; however, researchers have questioned the accuracy of visual analysis due to limited reliability and inflated Type 1 error rates (DeProspero & Cohen, 1979; Matyas & Greenwood, 1990a, 1990b). Visual analysis of graphed data involves careful consideration of patterns of level, trend, and variability across intervention phases, and several features of single-case data can make these judgments more difficult.

Visual judgments are more prone to error when significant baseline trend (i.e., increases or decreases in behavior across baseline data) is present (Parker, Cryer, & Byrns, 2006). Accordingly, behavior analysts are encouraged to delay phase changes when baseline trend is present until it is stable because it is difficult to ascertain the effects of the introduced variable (Cooper, Heron, & Heward, 2007). Despite this recommendation for practice, Parker et al. (2006) reported 41% of 165 published studies included in a review had significant baseline trend that was not accounted for in judgments of intervention effectiveness. The presence of baseline trend can bias visual judgments due to the spurious appearance of a mean phase shift (i.e., an increase or decrease in behavior on average from baseline to intervention phases). With significant baseline trend, mean phase shifts can be partially or totally explained by continuation of baseline trend into intervention phases.

In addition, single-case data commonly exhibit autocorrelation, which is the extent to which subsequent values on a variable can be predicted by prior values. When single-case data are graphed, autocorrelation can manifest as non-random trends (e.g., linear increases or decreases and/or curvature) that are unrelated to intervention effects and may complicate visual analysis (Matyas & Greenwood, 1997). Although the extent to which autocorrelation impacts visual analysis has been debated (e.g., Huitema, 1985, 1988), some studies have indicated that visual judgments of intervention effects become less reliable (Matyas & Greenwood, 1990b) and too liberal (Matyas & Greenwood, 1990a) when single-case data exhibit positive autocorrelation.

1.2. Methods to Improve Visual Analysis

Several strategies have been recommended to reduce errors in visual analysis, including (a) the incorporation of visual aids in graphs (i.e., inclusion of trend lines), (b) calculation of supplemental statistics, and (c) the use of formal decision criteria. Regarding visual aids, researchers have studied the effects of including trend lines in graphs on visual judgments with mixed results. Although the addition of trend lines to graphs has been found to increase interrater reliability (Bailey, 1984) and agreement between visual and statistical analyses (Rojann & Schulze, 1985), more recent research has found no improvements in decision accuracy (Normand & Bailey, 2006; Stocks & Williams, 1995). Of concern, when asked to verbally describe their decision making process while inspecting graphs, raters did not report greater attention to trend when trend lines were included in graphs. Instead, raters relied mostly on mean phase shifts, even when apparent shifts were solely due to continuation of baseline trend (Normand & Bailey, 2006).

In addition to incorporating visual aids, statistical procedures to control for baseline trend (i.e., calculation of effect size) may reduce errors in visual analysis. For example, Allison and Gorman (1993) and Parker et al. (2006) presented algorithms for adjusting multiple regression estimates of effect size to account for baseline trend, and less biased statistical methods to estimate effect size in the presence of baseline trend continue to be developed (e.g., Solanas, Manolov, & Onghena, 2010). Despite the availability of statistical methods to account for baseline trend and autocorrelation in the calculation of effect sizes, incorporation of statistical analyses in single-case research is uncommon, most likely due to the complexity of statistics necessary to address particular features of single-case data (e.g., limited quantity of data, autocorrelation, and the non-normal distribution of dependent variables; Shadish, Rindskopf, & Hedges,