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Benefits of Process Data for Evaluating the Differential Effectiveness of App-Based Treatments

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Differential effect analysis can reveal the preconditions for effective interventions by highlighting variations in intervention outcomes. The growing use of digital tools, such as learning apps, provides rich process data on response times and response behavior, offering insights into how participants interact with these apps. We use this information source and bridge psychometric research on controlling for disengaged responding with differential effect analysis to evaluate how variations in the usage of learning apps contribute to heterogeneity in intervention effectiveness. Specifically, we consider different response-time-based indicators to identify disengaged behavior, including thresholds for overly short response times, Gaussian mixture modeling, and model-based approaches that integrate item responses and response times (e.g., Wise & Kong, 2005; Wise, 2017; Ulitzsch et al., 2020; 2023). We demonstrate how these indicators can be integrated into the EffectLiteR framework, which specifies a structural equation model for differential effect analyses with latent variables (Mayer et al., 2016; Sengewald & Mayer, 2024). Finally, we compare the different modeling strategies and investigate the benefits of using the disengagement indicators in an empirical application. For this, we rely on the work of Torkildsen et al. (2022), who constructed an app-based morphological training program and evaluated its effectiveness in a randomized controlled trial with 717 second-grade students. Using the empirical data, we examine the heterogeneity of the morphological training effects in relation to the pre-treatment characteristics of the students and the gains achieved by including the different disengagement indicators, focusing on their impact on explained outcome variance and effect size differences. Our findings identify baseline characteristics that predict greater benefits from the training and highlight how different modeling strategies for disengagement indicators influence the conclusions. Beyond the practical insights into the utility of process data, the results demonstrate the application of the advanced modeling strategies for differential effect analysis.

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