Evidence-Based Communication Assessment and Intervention

Taylor & Francis
Taylor & Francis Group

Evidence-Based Communication Assessment and Intervention

ISSN: (Print) (Online) Journal homepage: www.tandfonline.com/journals/tebc20

Advancements in meta-analysis of single-case experimental designs

Oliver Wendt & David Rindskopf

To cite this article: Oliver Wendt & David Rindskopf (2023) Advancements in meta-analysis of single-case experimental designs, Evidence-Based Communication Assessment and Intervention, 17:1, 1-5, DOI: 10.1080/17489539.2023.2272906

To link to this article: https://doi.org/10.1080/17489539.2023.2272906

Published online: 23 Nov 2023.

Evidence-Based Communication Assessment and Intervention, 2023
Vol. 17, No. 1, 1-5, https://doi.org/10.1080/17489539.2023.2272906

Editorial

Advancements in meta-analysis of single-case experimental designs

Oliver Wendt[a,b] **& David Rindskopf**[c]
[a]Cognitive and Emotional Disabilities, College of Human Sciences, University of Potsdam, Potsdam, Germany; [b]Human Development and Family Science, Purdue University, West Lafayette, IN, USA; [c]CUNY Graduate Center, New York, NY, USA

It is our great pleasure to introduce a mini-series of special issues devoted to the current state of the art in meta-analysis of single-case experimental designs (SCEDs). The first part of the mini-series can be found in Volume 15, Issue 3, while the second part is published in the current volume.

The adoption of evidence-based practice in the field of communication disorders reflects the need of practitioners and their clients to know how effective speech, language and hearing interventions truly are. Applied researchers and clinicians are asking what outcomes can be targeted and will be improved through current intervention approaches, what is the extent of improvement that can be expected, how long do interventions need to last, and what will be the costs? Furthermore, funding agencies and other stakeholders are increasingly raising the question whether common policies, practices, and programs actually generate a benefit, or in the worst scenario contain a risk for the client (Turner et al., 2007). One individual study can typically not answer all of these questions in a convincing manner. A more persuasive approach is to synthesize multiple studies to create aggregated evidence and document the effectiveness or efficacy of an intervention under investigation. The synthesis of individual studies can provide an inclusive overview on the contemporary research base, and present firm evidence in favor of, or against, an intervention (Schlosser, 2006). Meta-analysis is a rigorous aggregation tool to derive these urgently needed research syntheses. Over the last two decades, many fields in health care and education have adopted hierarchies of treatment evidence to provide guidance for clinical and educational decision-making (e.g., Schlosser & Raghavendra, 2004). In these evidence hierarchies, meta-analyses of treatment or intervention studies represent one of the most persuasive forms of scientific evidence and rank above individual experimental studies or non-systematic research syntheses. Scientific disciplines where SCEDs are the prevailing or frequently used method to demonstrate the efficacy of an intervention have positioned SCEDs on the same evidence level as quasi-experimental group designs, with a synthesis of either design ranking toward the top of the hierarchy (Schlosser & Raghavendra, 2004).

Despite the widespread use of SCEDs and the growing need for their synthesis, meta-analysis of these designs has not always been an issue without debate. For example, Pennington (2005) argues against the synthesis of SCEDs as bias from subject

For correspondence: Oliver Wendt, Cognitive and Emotional Disabilities, College of Human Sciences, University of Potsdam, Potsdam 14476, Germany. E-mail: oliver.wendt@uni-potsdam.de; aacresearch@aol.com

selection in non-randomized designs cannot be prevented. Shadish et al. (2008) report a "traditional hostility" against the analysis and synthesis of SCEDs in some parts of the academic community that follow a behavior-analytic paradigm. As these authors recount, a manuscript including a meta-analysis of SCEDs was once rejected with the argument that "relatively few behavior analysts are likely to accept meta-analysis as an appropriate tactic for extending or supplementing within-subject experimental designs" (Shadish et al., 2008, p. 188). Fortunately, these times are behind us. As Schlosser puts it in the introduction to the very first special issue on meta-analysis of SCEDs over a decade ago, the issue of "whether or not to synthesize single-subject experimental designs using meta-analytic techniques is no longer in question" (Schlosser & Sigafoos, 2008, p. 117). Some of the hesitation about the statistical synthesis of SCEDs may have come from a lack of understanding what those proper meta-analytic techniques would be and how to meaningfully implement them. There are several good reasons to justify a statistical synthesis of SCED research results (Beretvas & Chung, 2008): (a) A statistical aggregation of study results may be able to yield a more objective summary of intervention outcomes when looking at the extant research literature through a meta-analytic lens. (b) The application of meta-analytic procedures also yields more and better opportunities to draw inferences regarding the generalization of study findings across individuals. (c) In addition, researchers have a chance to explore any differences observed in individual studies in more depth. (d) Finally, the statistical analysis of a body of studies can lead to a much more precise estimate of a treatment effect than what would be possible on the basis of an individual study, where unstable data patterns and/or small changes between phases might make it difficult to detect a treatment effect at all (Nourbakhsh & Ottenbacher, 1994). An additional advantage of meta-analysis of SCEDs is the direct usage of data at the individual case-level instead of summary statistics; a similar approach is nowadays pursued for group designs as part of individual patient data (IPD) meta-analysis (van Walraven, 2010).

Although considerable progress has been made over the last decade in developing and contrasting newer statistical methods for the meta-analysis of SCEDs, there is still much debate in the SCED community how to best summarize SCED results with respect to different data scenarios and types of designs. With this mini-series of special issues, we intend to provide a forum for SCED methodology researchers to demonstrate most recent advancements in the use of meta-analytic procedures for the synthesis of SCED studies.

The first issue in the mini-series is focused on the application of one of the most commonly applied effect size descriptors for SCEDs and concludes with an exploration into deriving meaningful categorical bands or "benchmarks" for meaningful and accurate interpretation of effect size estimates calculated from SCED data. In more detail, these contributions can be summarized as follows:

The first paper by Fingerhut et al. (2021a) provides a Monte Carlo simulation study investigating the influence of within-case variability on the estimate of three different variants of the Tau-U index. The results are contrasted to the performance of a hierarchical linear modeling (HLM) approach to determine the robustness of both techniques. The simulation study shows that the magnitude of the within-case variance influences the Tau-U indices particularly in those scenarios where the

true intervention effect is small in the presence of relatively large within-case variance. For the HLM-based effect size measure, within-case variance did not systematically impact the magnitude of obtained estimates. The authors are following up on these important findings with a second paper offering concrete recommendations for applied researchers when deciding which Tau-U variant to use with two different SCED scenarios (Fingerhut et al., 2021b). A flowchart is introduced and demonstrated with two different SCED scenarios. The proposed process guides researchers in the selection of the proper Tau-U metric based on the nature of their data and their research questions. This effort prevents inappropriate implementations of Tau-U and potentially invalid conclusions of intervention effectiveness.

To further enhance the application and interpretation of effect size metrics for SCED data, Vannest and Sallese (2021) tackle the issue of generating proper benchmarks for SCED effect size estimates that allow for contextual and comparative interpretation. Their review of published SCED meta-analyses reveals that benchmarking opportunities are largely underutilized, and contemporary interpretative practices overly rely on generic benchmarks. Vannest and Sallese illustrate three processes for proper benchmarking that applied researchers can incorporate into their own meta-analytic reviews.

The second issue in the mini-series continues the contribution to contemporary meta-analytic procedures by covering a variety of topics including a review of current characteristics of SCED meta-analyses, an exploration of synthesis techniques for alternating treatment and changing criterion designs, a comparison of non-overlap metrics with visual analysis, and an investigation into most recent changes within the What Works Clearinghouse standards for SCEDs. In more detail, the authors' contributions can be summarized as follows:

Jamshidi, Heyvaert, Declercq, Fernández-Castilla, Ferron, Moeyaert, Beretvas, Onghena, and Van den Noortgate (2023) present a comprehensive review of the characteristics in 178 meta-analyses of SCED studies. Their results reveal that despite considerable advancements in SCED meta-analytic methodology over the last two decades, a vast number of SCED meta-analyses still use more basic methods. The authors urge the SCED research community to be more aware of recent methodological and statistical advancements that have emerged to produce SCED syntheses of high methodological quality.

Manolov, Onghena, and Van den Noortgate (2023) are exploring meta-analytic techniques for less common types of SCEDs, including the alternating treatment design, and changing criterion design. These designs are not as prominent in the SCED research literature but nevertheless should not be excluded from meta-analytic syntheses to avoid biased aggregations of available data. The authors are showcasing a multi-level modeling approach to accomplish this purpose and are demonstrating how proper design matrices can make these processes more consistent and transparent.

Because there is still a need for non-overlap metrics for meta-analyses of more heterogeneous SCED data, Alresheed and Machalicek (2023) are looking at recent advancements in non-parametric ES descriptors and are comparing their performance to visual analysis results. Their findings show that the non-overlap metrics under investigation possess high degrees of sensitivity and agreement with visual analysis but are prone to yielding Type I errors. Visual analysis, on the other hand, turned out to be less sensitive and more prone to Type II errors. The authors argue in favor of developing and extending visual analysis

tools that improve on reliability and accuracy.

Finally, Moeyaert and Dehghan-Chaleshtori (2023) are drawing attention to the topic of quality appraisal in meta-analyses of SCED studies. One of the most widely used appraisal tools for rating methodological quality are the What Works Clearinghouse (WWC) Design and Evidence Standards, the first version of which appeared in 2010. A decade later, more substantial revisions were incorporated into the WWC standards raising the question how these additions might impact quality ratings and subsequent meta-analysis of SCED studies. The authors are able to show that the revised WWC standards do not produce different quality ratings of SCEDs, but are more inclusive in terms of providing specific quality rating criteria for a wider array of design types.

The contributors to this mini-series on advancements in meta-analysis of SCEDs represent the leaders on developing scientifically based SCED synthesis methods. The emergence of a community of such researchers, all dedicated to further developing the current state of the art, bodes very well for the prospects of enhancing evidence-based policy and decision-making. It is refreshing to look at the potential of the contributions the authors have made for this mini-series. Their continued efforts are enabling applied SCED researchers to participate in the evidence-based practice movement by producing methodologically sound research syntheses that are urgently needed to guide clinical practice.

It has been our great pleasure to work with the authors and oversee their development of trailblazing contributions as we were preparing this mini-series of special issues. We also like to acknowledge the many expert reviewers who did not hesitate to lend their time and resources to ensure that manuscripts were meeting high standards. Because of these joined forces, we are very confident that methodologically sound research focused on synthesizing SCED data will continue to evolve and advance the work of many applied SCED researchers in our field who are aiming to generate one of the highest levels of research evidence by conducting meta-analyses of SCED studies.

DISCLOSURE STATEMENT

No potential conflict of interest was reported by the author(s).

FUNDING

The author(s) reported that there is no funding associated with the work featured in this article.

ORCID

Oliver Wendt http://orcid.org/0000-0002-7363-3779
David Rindskopf http://orcid.org/0000-0003-3344-0320

REFERENCES

Alresheed, F., & Machalicek, W. (2023). A systematic comparison of non-overlap metrics and visual analysis in single-case experimental design. *Evidence-Based Communication Assessment and Intervention*, 1–19. https://doi.org/10.1080/17489539.2023.2200813

Beretvas, S. N., & Chung, H. (2008). A review of meta-analyses of single-subject experimental designs: Methodological issues and practice. *Evidence-Based Communication Assessment and Intervention*, *2*(3), 129–141. https://doi.org/10.1080/17489530802446302

Fingerhut, J., Xu, X., & Moeyaert, M. (2021a). Impact of within-case variability on Tau-U indices and the hierarchical linear modeling approach for multiple-baseline design data: A monte carlo simulation study. *Evidence-Based Communication Assessment and Intervention*, *15*(3), 115–141. https://doi.org/10.1080/17489539.2021.1933727

Fingerhut, J., Xu, X., & Moeyaert, M. (2021b). Selecting the proper Tau-U measure for single-case experimental designs: Development and application of a decision flowchart. *Evidence-Based Communication Assessment and Intervention*, *15*(3), 99–114. https://doi.org/10.1080/17489539.2021.1937851

Jamshidi, L., Heyvaert, M., Declercq, L., Fernández-Castilla, B., Ferron, J. M., Moeyaert, M. S., Beretvas, N., Onghena, P., & Van den Noortgate, W. (2023). A systematic review of single-case experimental design meta-analyses: Characteristics of study designs, data, and analyses. *Evidence-Based Communication Assessment and Intervention*, 1–25. https://doi.org/10.1080/17489539.2022.2089334

Manolov, M., Onghena, P., & Van den Noortgate, W. (2023). Meta-analysis of single-case experimental designs: How can alternating treatments and changing criterion designs be included? *Evidence-Based Communication Assessment and Intervention*, 1–28. https://doi.org/10.1080/17489539.2022.2040164

Moeyaert, M., & Dehghan-Chaleshtori, M. (2023). Evaluating the design and evidence of single-case experimental designs using the What Works Clearinghouse standards. *Evidence-Based Communication Assessment and Intervention*, 1–19. https://doi.org/10.1080/17489539.2022.2139148

Nourbakhsh, M. R., & Ottenbacher, K. J. (1994). The statistical analysis of single-subject data: A comparative examination. *Physical Therapy*, *74*(8), 768–776. https://doi.org/10.1093/ptj/74.8.768

Pennington, L. (2005). Book review [Review of the book "The efficacy of augmentative and alternative communication: Toward evidence-based practice"]. *International Journal of Language and Communication Disorders*, *40*(1), 99–102. https://doi.org/10.1080/13682820400006028

Schlosser, R. W. (2006). *The role of systematic reviews in evidence-based practice, research, and development* (Focus: Technical Brief No. 15). http://www.ncddr.org/kt/products/focus/focus15/

Schlosser, R. W., & Raghavendra, P. (2004). Evidence-based practice in augmentative and alternative communication. *Augmentative and Alternative Communication*, *20*(1), 1–21. https://doi.org/10.1080/07434610310001621083

Schlosser, R. W., & Sigafoos, J. (2008). Meta-analysis of single-subject experimental designs: Why now? *Evidence-Based Communication Assessment and Intervention*, *2*(3), 117–119. https://doi.org/10.1080/17489530802520429

Shadish, W. R., Rindskopf, D. M., & Hedges, L. V. (2008). The state of the science in the meta-analysis of single-case experimental designs. *Evidence-Based Communication Assessment and Intervention*, *2*(3), 188–196. https://doi.org/10.1080/17489530802581603

Turner, H. M., Nye, C., Ortiz, M., Liu, E., & Eisenstein, E. L. (2007). Producing systematic reviews of interventions in speech-language pathology: A framework for sustainability. *Evidence-Based Communication Assessment and Intervention*, *1*(4), 202–213. https://doi.org/10.1080/17489530701856577

Vannest, K. J., & Sallese, M. R. (2021). Benchmarking effect sizes in single-case experimental designs. *Evidence-Based Communication Assessment and Intervention*, *15*(3), 142–165. https://doi.org/10.1080/17489539.2021.1886412

van Walraven, C. (2010). Individual patient meta-analysis—rewards and challenges. *Journal of Clinical Epidemiology*, *63*(3), 235–237. https://doi.org/10.1016/j.jclinepi.2009.04.001