OPEN SCIENCE B R I E F

To help inform the special education research community, these briefs feature information on prominent open science practices. Content comes from our series of short articles in the DR newsletter, Focus on Research, as well as additional content developed by DR members.

RESEARCH

OPEN SCIENCE AND SINGLE-CASE DESIGN

Open-science reforms have the potential to strengthen the credibility of research, help address the replication crisis, and bridge the research-to-practice gap (Cook et al., 2018). *Focus on Research* is featuring a series of articles introducing prominent open-science practices. Open science evolved primarily in the context of group quantitative research. However, open science has relevance for other research designs, such as single-case and qualitative methods. In this article, we consider **how open science may apply to single-case design research**. We briefly describe issues in single-case design research that open-science reforms may address, review how core open-science practices (e.g., preregistration, open data and materials, preprints) apply to and can benefit single-case research, and consider limitations and challenges for using open science in single-case design.

Issues in Single-Case Design Germane to Open Science

Contemporary open-science reforms evolved, at least in part, in response to concerns about bias associated with researchers engaging in questionable research practices to obtain statistically significant results (Baker, 2016; Makel et al., 2021). For example, bias in individual studies and entire research bases may be introduced by p-hacking (i.e., trying many different analytic approaches until finding one that yields statistically significant results), outcomereporting bias (i.e., cherry-picking or reporting only analyses that yielded significant results), and publication bias (i.e., studies without significant findings being published at lower rates than those with significant findings).

Researchers do not traditionally evaluate hypotheses in single-case design studies using pvalues and tests of statistical significance but instead examine the presence of functional relations between independent and dependent variables through visual analysis of graphed data. Although single-case researchers may not, then, seek to obtain statistically significant results, we suspect single-case research is not immune to many of the broader issues that precipitated open-science reforms (Cook, Johnson, et al., 2021). For example, reviews have shown that

single-case studies with larger effects are more likely to be published (i.e., publication bias; Dowdy et al., 2020; Sham & Smith, 2014), some single-case researchers reported they would drop cases with small effects from a study before submitting for publication (i.e., outcome-reporting bias; Shadish et al., 2016), and visual analysis is often conducted subjectively (Ninci et al., 2014). Thus, single-case researchers may feel studies with large effects and functional relations are more likely to be published, influencing how they conduct and report their research. Moreover, like other published scholarship, many single-case studies are behind a paywall, inaccessible to many stakeholders (e.g., teachers, parents).

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Applications of Open-Science Practices to Single-Case Design

Cook, Johnson, et al. (2021) suggested that core open-science practices (e.g., preregistration, open data, and materials, preprints) can be applied to increase the transparency, credibility, and accessibility of single-case design research. *Preregistration* involves researchers specifying and publicly registering key study elements (e.g., hypotheses, variables, outcome measures, data analysis) before conducting the study (Gehlbach & Robinson, 2018).

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In addition to providing transparency regarding the research process, preregistrations make many questionable research practices (e.g., p-hacking, outcome-reporting bias) possible to identify. Johnson and Cook (2019) provided a rationale and guidelines for preregistering single-case studies, especially those designed to test a priori hypotheses regarding the effects of a predetermined intervention on one or more specific outcomes. Preregistration of critical elements of single-case studies such as hypotheses, participants, outcome measures, and criteria for conducting visual analyses may heighten the credibility of single-case studies.

Open data involve publicly sharing one's data so that other researchers can check published analyses, examine whether reported findings are robust across different analytic choices, and investigate novel research questions. Open data are often accompanied by shared analysis code, allowing other researchers to reproduce reported analyses exactly. Outcome data in single-case studies are displayed graphically and, therefore, are already shared in some sense. However, sharing raw data saves time and reduces potential errors by eliminating the need to extract data values. Moreover, single-case researchers can share data not typically graphed (e.g., social validity data, fidelity data). Finally, single-case researchers can share code for any statistical analyses conducted, such as computing effect sizes. Single-case researchers can also share study materials (i.e., open materials) such as intervention protocols and stimuli, outcome measures, and fidelity checklists to facilitate (a) other researchers replicating the study and (b) practitioners implementing study procedures (Cook, Fleming, et al., 2021). Open materials seem especially relevant for single-case researchers given the applied nature of most single-case studies.

Preprints involve authors posting noncopyrighted versions of manuscripts on freely accessible registries (e.g., https://edarxiv.org; Fleming & Cook, 2021). Much of the published research base, including single-case studies, is behind a paywall and can only be accessed by paying the publisher (either individually or through institutional subscriptions). This means that many of the desired end-users of single-case design studies (e.g., teachers, parents) cannot access the research. Especially given the highly applied nature of most single-case studies, posting preprints that anyone with internet access can access freely seems like an important step in bridging the gap between research and practice.

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Limitations and Challenges

Engaging in open-science practices, no matter the type of research, takes time and effort on the part of the researchers. Preregistration, for example, requires thoroughly thinking through and documenting one's plans for an entire study before data are even collected. Moreover, engaging in open-science practices is not an established norm among special education researchers. Additional awareness of and supports for engaging in open science are needed in the field generally and may be especially important for single-case researchers given that open-science reforms have traditionally targeted group research. Finally, although some openscience practices play out the same for all research designs (e.g., preprints), others will play out in unique ways that are still being determined for single-case research.

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because some decisions in most single-case studies are responseguided, preregistration of many single-case studies are likely possible but will involve additional procedures

For example, preregistration of study procedures may be antithetical to some single-case researchers who seek to employ inductive reasoning to develop study procedures after beginning data collection (Johnson & Cook, 2019). Alternatively, because some decisions in most single-case studies are response-guided (e.g., when to end the baseline phase), preregistration of many single-case studies are likely possible but will involve additional procedures (e.g., decision trees) to specify under what conditions researchers will take specific actions (Cook, Fleming, et al., 2021). In sum, the specifics of how some aspects of open science will be applied in single-case research are not yet firmly established.



Enhance replicability through transparent reporting of plans, deviations, and data.

- Preregister studies and document a priori procedures, noting changes made via response-guided decisions.
- Describe the processes for responsedependent decisions.
- Share data and study materials using openscience resources.

RESOURCES ••••••

RECOMMENDATIONS FOR PREREGISTERING SINGLE-CASE DESIGN RESEARCH:

Johnson, A. H., & Cook, B. G. (2019).
Preregistration in Single-Case Design Research.
Exceptional Children, 86(1), 95–112.
https://doi.org/10.1177/0014402919868529

Advice on Selecting Quantitative Measures from an A Priori Perspective:

 MAnolov, R., Moeyaert, M., & Fingerhut, J. E. (2022). A Priori Justification for Effect Measures in Single-Case Experimental Designs. Perspectives on Behavior Science, 45(1), 153– 186.https://doi.org/10.1007/s40614-021-00282-2

PRE-REGISTRATION DATABASE THAT INCLUDES SINGLE-CASE DESIGNS:

https://sreereg.icpsr.umich.edu/sreereg/

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