Promoting Open Science to Increase the Trustworthiness of Evidence in Special Education

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Abstract

Scientific evidence should guide the selection of practice for individuals with disabilities. Scientific evidence, however, must be trustworthy to move special education toward greater empirical certainty and more effective policies and practices. Transparency, openness, and reproducibility increase the trustworthiness of evidence. We propose that researchers in special education adopt emerging open science reforms such as preprints, data and materials sharing, preregistration of studies and analysis plans, and Registered Reports. Adoption of these practices will require shifts in cultural norms, guidelines, and incentives. We discuss how adopting open science practices can advance the quality of research and, consequently, policy and practice in special education.

Promoting Open Science to Increase the Trustworthiness of Evidence in Special Education

Research about individuals with disabilities and the provision of beneficial services for them—an endeavor that spans diverse disciplines including education, rehabilitation counseling, psychology, sociology, and public policy—requires trustworthy evidence (Carnine, 1997; Slavin, 2002). The practice of serving individuals with disabilities advances when practitioners sensitively employ scientifically validated methods and monitor whether their efforts are benefitting those individuals with whom they work (Cook & Odom, 2013; Zigmond, 1997). Some who provide or recommend educational services for individuals with disabilities may eschew evidence-based practices in favor of methods supported by more subjective evidence (e.g., personal experience and opinion; cf., Landrum, Cook, Tankersley, & Fitzgerald, 2002). However, they do so at the risk of harming or disrupting the services of not only the individuals with disabilities, but also family members and other professionals. It is incumbent upon professionals who provide educational services for individuals with disabilities to adopt practices based on evidence about those methods' benefits (Crockett, 2004). Importantly, the evidence on which practice and policy is based should be trustworthy. Many academic disciplines are implementing open science reforms to heighten the trustworthiness of research evidence.

The purpose of this paper is to explain how open science aligns with tenets of special education research and to recommend open science practices for advancing trustworthy science in special education. In doing so, we (a) discuss how openness, transparency, and reproducibility of findings support trustworthy research; (b) examine issues in contemporary research generally, and more specifically, within special education, that make open science reforms necessary; (c) describe core principles and reforms associated with open science; and (d) argue that open science reforms are feasible and well-suited for special education.

Trustworthy Research is Open, Transparent, and Reproducible

Trustworthiness refers to the extent to which the research methods and data underlying findings can be considered reliable and valid representations of reality (Carnine, 1997; Odom, 2005). Trustworthiness (i.e., validity) of research findings is based on many considerations, including rigor of research design and quality of study method. Scholars in special education have sought to improve the trustworthiness of their research via increased rigor and quality for generations. For example, in 1952 the Council for Exceptional Children's Research Committee recommended increasing knowledge and application of "new research techniques which can be used with exceptional children" (Cain et al., p. 82) to remedy many "strong statements and convictions, but few facts" (p. 81) available to special educators. Fifty years later, Gersten et al. (2005) and Horner et al. (2005) proposed (a) quality indicators for conducting and reporting rigorous research and (b) standards for identifying evidence-based practices from high-quality, experimental research in special education. Implementation of these quality indicators has, in turn, promoted increased rigor in special education research in areas such as reporting of treatment fidelity and social validity (Clarke, Zakszeski, & Kern, 2018). Open science builds on these efforts to enhance the trustworthiness of research evidence by increasing its transparency, openness, and reproducibility (Nosek et al., 2015).

Transparency and *openness* relate to the entire research process, including study design, conduct, reporting, and review (Miguel et al., 2014; Nosek & Bar-Anan, 2012; Nosek et al., 2015). Transparency of study design facilitates clarity of research plans and ensures it is clear whether reported findings were the result of confirmatory tests of a-priori hypotheses or exploratory results identified post hoc. Transparency of research conduct facilitates clarity of deviations from original design plans. Transparency of reporting ensures that the research

consumer is aware of all evidence generated, not just evidence selected for the published report. Transparency of review exposes peer evaluation of research to facilitate better dissemination of its strengths and weaknesses. Without transparency, scientific progress can be impeded by weakening self-correction processes that rely on accurate and complete insight into the research process, and by interfering with accumulating evidence through reuse and extension of prior materials and data. Moreover, transparency is a core value of science and a means by which research establishes credibility and trustworthiness.

Truly open science involves more than transparency. Research needs to be open and shared to promote efficiency and trustworthiness. Sharing research materials and data enables others to (a) understand the original research protocol more completely, (b) check and verify reported analyses, (c) critique and improve the materials and protocols, and (d) reuse the materials or data for replication or other research purposes (Miguel et al., 2014; Molloy, 2011). Instead of limiting access and analyses to one research team, open data and materials allow a far wider group of researchers to investigate potentially important questions with shared resources and accumulating evidence that will benefit individuals with disabilities.

Reproducibility refers to the extent to which research findings are robust and repeatable (Goodman, Fanelli, & Ioannidis, 2016). This includes reproducibility of methods to demonstrate that application of the original analytic code to the original data achieved the reported result. It also includes estimating the robustness of evidence by evaluating the extent to which findings using the same data are consistent across a variety of reasonable analytic decisions, such as how to treat outliers and which covariates to include (LeBel et al., in press; Silberzahn et al., 2017). Reproducibility also includes replication in which the same research question is tested with new data under conditions in which the same result is expected (Nosek & Errington, 2017). Finally,

reproducibility is related to examination of generalizability, in which a finding is presumed to hold beyond the original data, but the boundary conditions of the phenomenon may not be clearly specified or understood. Thus, generalizability is a matter of empirical investigation and theoretical elaboration. Especially given the many sources of error associated with research in the applied, field-based studies typically conducted in special education, reproducibility of various forms is critical for establishing trustworthy evidence.

Unfortunately, rather than being transparent, open, and reproduced, many aspects of research are protected, closed, and unverified. The result is evidence that is not always trustworthy and which may contribute to ineffective policy and practice. In the following section, we discuss issues in scientific research, generally and in special education specifically, that underlie the need for open science reforms.

Problems with Scientific Research

The need for heightened transparency, openness, and reproducibility in research arises from diverse problems in the scientific endeavor. Although science is the best tool humans have devised to build shared knowledge, it is not free of shortcomings. Advocates for science, including those in education (e.g., Shavelson & Townes, 2002), often argue that problems within the scientific enterprise are inherently self-correcting but that progress is uneven. Why does the accumulation of scientific knowledge not progress smoothly and consistently forward in special education? Some reasons lie in the contemporary culture of scientific research, whereas others can be better understood in the context of special education.

Concerns about the Culture of Contemporary Science

Consistent with the principles of transparency, openness, and reproducibility, Merton (1942) suggested that trustworthy science be guided by four norms: communalism, universalism,

disinterestedness, and organized skepticism (see Stodden, 2010). Although US scientists indicated strong conceptual support for these norms, they reported contrary counternorms of secrecy, particularism, self-interestedness, and organized dogmatism often prevailed in actual research practice (Anderson, Ronning, Martinson, & DeVries, 2007). Mitroff initially identified these counternorms in interviews with elite scientists involved in the Apollo lunar missions whose research, in direct contrast to Mertonian norms, involved "often fierce, sometimes bitter, competitive races for discovery and the intense emotions which permeate the doing of science" (1974, p. 585).

Observers of contemporary scientific culture have suggested that the behavior of the Apollo scientists has become the rule rather than the exception. A publish-or-perish culture that prioritizes self-interest, discovery of novel findings, publishing in high-impact journals, and securing funding over sound science appears to be pervasive (Casadevall & Fang, 2012; Giner-Sorolla, 2012; Gunsalus & Robinson, 2018; Nosek, Spies, & Motyl, 2012). Because researchers have considerable flexibility when designing, conducting, and reporting studies, they have multiple opportunities to manipulate the research process in subtle ways to increase the likelihood of desired (e.g., novel, positive, statistically significant) results (Simmons, Nelson, & Simohnson, 2011; Witcherts et al., 2016). Researchers seldom falsify data (John, Loewenstein, & Prelec, 2012), which is censured as scientific misconduct. However, questionable research practices such as manipulating statistical analyses until desired results are produced (i.e., data fishing and p-hacking; see https://projects.fivethirtyeight.com/p-hacking/ for an interactive demonstration), hypothesizing after results are known (i.e., HARKing), and selectively reporting analyses and publishing studies with positive results (i.e., reporting and publication bias) are not so clearly proscribed. Researchers report engaging in these questionable research practices,

which can affect study findings and influence the trustworthiness of evidence (John et al., 2012; Simmons et al., 2011).

Because error is inherent in research, replication is a critical part of the broader scientific process for identifying and correcting invalid findings (Travers, Cook, Therrien, & Coyne, 2016). Unfortunately, replication studies are seldom conducted (Makel, Plucker, & Hegarty, 2012; Makel & Plucker, 2014). Interestingly, when researchers have conducted replication studies, results have often failed to validate original findings (Camerer et al., 2016, in press; Ebersole et al., 2016; Klein et al., 2014; Open Science Collaboration, 2015). For example, Open Science Collaboration (2015) directly replicated 100 studies in psychology. Whereas 97 of the original studies reported statistically significant primary findings, only 36 of the replication studies did. A failure to replicate does not necessarily mean the conclusion that the original study was a false positive, but it does demonstrate that the reproducibility of the published literature may be more uncertain than presently understood and likely warrants more circumspect claims about the present evidence (Randall & Welser, 2018).

Moreover, studies with null findings are scarce in the published research base, especially in the social sciences (Fanelli, 2010; Sterling, 1959). Despite the importance of studies with null findings for identifying ineffective interventions and the boundaries of effective practices (Cook & Therrien, 2017; Therrien & Cook, 2018), researchers often fail to submit them for publication (i.e., publication bias; Franco, Malhotra & Simonovits, 2014; Greenwald, 1975), likely due to perceptions that such research is not valued and is less likely to be published. In addition, even when studies with null findings are submitted for review, journals are often reticent to accept them because null findings are difficult to interpret (Ferguson & Heene, 2012). Thus, research evidence is likely skewed toward positive findings, with few replication studies conducted to

identify potentially false-positive findings (Ioannidis, 2012), leading to a literature base with potentially exaggerated evidence for positive effects (Munafo et al., 2017).

The Nature of the Special Education Research

Special education researchers may believe that the discipline is not subject to many or even some of these problems. They may consider counternorms such as dogmatism, self-interest, secrecy and the like to be absent from special education research. However, the degree to which special education researchers engage in questionable practices and the special education research base reflects bias are empirical questions that researchers are just beginning to investigate. The contingencies under which researchers in special education operate may differ in specific ways from those in other fields (e.g., less notoriety and smaller financial rewards), resulting in, for example, less engagement in questionable research practices. However, we expect that the culture, behavior, and outcomes of researchers in special education share at least some commonalities with other fields, and some aspects of culture within special education may pose particular threats to the trustworthiness of the field's research evidence.

Researchers have begun to identify potential threats to the trustworthiness of the professional literature bases in special education, such as scarcity of direct replications and the existence of publication bias. In a review of publications in three journals in the area of learning disabilities, Therrien and Cook (2018) found that only 4% of intervention studies reported solely null findings. Kittleman, Gion, Horner, Levin, and Kratochwill (2018) reviewed publications in the highest ranked journals in special education, general education, and educational psychology and counseling, and also found that only 4% of intervention studies reported solely null findings. One possible explanation of these findings is that researchers in special education seldom

investigate ineffective interventions. However, publication bias likely contributes to the scarcity of published null findings in the extant research base.

Publication bias (i.e., the file-drawer problem; Rosenthal, 1979) occurs when studies with positive findings are more likely than chance to be represented in the published literature than those with null or negative findings. Gage, Cook, and Reichow (2017) reported that one-third of 109 meta-analyses of group-research designs published in special education journals reflected possible publication bias, and that effects sizes were markedly larger in published versus unpublished studies included in a subset of the meta-analyses (d=0.89; see also Chow & Ekholt, 2018). In their review of single-case design studies on pivotal response theory for children with autism, Sham and Smith (2014) reported that the percentage of non-overlapping data was, on average, 22% higher in published studies than in unpublished dissertations. Publication bias may exist in special education research even when controlling for methodological quality. Given hypothetical research reports that differed only by results (i.e., the methods were the same), researchers indicated they were significantly more likely to (a) submit for publication and (b) recommend for publication (when acting as a reviewer) single-case design studies with large rather than small effect sizes (Shadish, Zelinsky, Vevea, & Kratochwill, 2016).

A bias toward studies with positive effects in special education is especially problematic given the dearth of direct replications conducted to identify false-positive findings. Consistent with findings from other fields (see Makel et al., 2012; Makel & Plucker, 2014), Makel et al. (2016) and Lemons et al. (2016) reported that only 0.5% and 0.4%, respectively, of articles published in special education were replication studies; and most of those were conceptual replications, which do not directly test the validity of previous findings. Although other reviews (Banerjee, Movahedazarhouligh, Millen, & Luckner, 2018; Cook, Collins, Cook, & Cook, 2016;

Therrien, Matthews, Hirsch, & Solis, 2016) indicated that special education researchers often conduct studies that conceptually replicate at least some aspects of previous studies, these authors found that special education researchers (a) seldom explicitly identify the purpose of their research as replication, and (b) almost never conduct direct replications.

It is possible that the strong tradition of advocacy in special education puts the field's research base at particular risk for bias. Advocacy has and continues to be a rich and powerful force in special education that underlies many advances in the rights and outcomes of individuals with disabilities (Giordano, 2007; Yell, Rodgers, & Rodgers, 1998). Advocacy can, however, sometimes conflict with the professional roles of special educators (see Frith, 1981), including researchers. Anecdotally, we hear researchers speak proudly about their passion for the interventions and theories they investigate. It is possible that some researchers' well-intentioned desires to improve quality of life for learners with disabilities by documenting positive effects of practices they believe in may influence the conduct, analysis, and reporting of research in subtle but important ways.

Principles and Key Elements of Open Science

We consider open science to be inclusive of the entire research lifecycle, referring to increasing transparency and accessibility of the outcomes, content, and process of research. By "outcomes of research," we refer to research reports and findings. By "contents of research," we refer to the materials, protocols, code, and data that are generated as a product of conducting the research. By the "process of research," we refer to the activities of generating and evaluating the research, such as (a) clarifying confirmatory versus exploratory analysis with preregistration and (b) making the revision history of an article and peer review transparent. By making all aspects of scientific research transparent, open, and reproducible the ultimate goal of open science can be

reached: "to accelerate scientific progress and discoveries and to turn these discoveries into benefits for all" (Masuzzo & Martens, 2017, p. 1). Although a broad array of reforms fall under the umbrella of open science (Pontika, Knoth, Cancellieir, & Pearce, 2015), in the subsequent sections we describe a few prominent open science approaches that show particular promise for increasing the trustworthiness and credibility of research evidence in special education.

Data Sharing

Arguably, data sharing is the best known aspect of open science. Among the many benefits of making data freely available are enabling others to verify reported analyses, permitting others to reanalyze data using different statistical approaches, allowing others to reuse data to examine new research questions, and supporting others' use of the data in research syntheses ("Frequently Asked Questions (FAQs) on Data Sharing," 2003). Additionally, sharing data may carry benefits for individual researchers. Studies with shared data are cited more frequently (see Dorch, 2012; Henneken & Accomazzi, 2011; McKiernan et al., 2016; Piwowar, Day, & Fridsma, 2007; Piwowar & Vision, 2013), and research data themselves are a citable contribution to the scholarly record (e.g., Nosek et al., 2015). When sharing data, researchers should abide by the FAIR principles: making data findable, accessible, interoperable, and reusable (Wilkinson et al., 2016). Researchers typically share data through discipline-specific or generalist repositories. Discipline-specific repositories may have a curatorial staff to assist in sharing data, which helps ensure that data are appropriately formatted for sharing (e.g., by checking for identifiable information) and include appropriate identifiers for later discoverability. Generalist repositories typically accept any data and are less likely to include curatorial services. The inaugural issue of *Advances in Methods and Practices in Psychological Science* includes primers (Levenstein & Lyle, 2018) and guiding principles in data sharing

(Gilmore, Kennedy, & Adolph, 2018) as well as discussion about sharing data that might contain sensitive information (Meyer, 2018). Guidelines (e.g., https://www.icpsr.umich.edu/files/deposit/dataprep.pdf) are available to assist researchers in formatting a variety of data types, including qualitative and quantitative, for sharing.

Fear of other researchers "scooping" one's original ideas is sometimes mentioned as a disincentive for increased transparency, particularly in regard to data sharing (Tenopir et al., 2011). It is unclear the degree to which such fears are based on actual instances of scientific misconduct (i.e., taking credit for contributions made by others). It is important to note that data sharing generally refers to publishing data related to a specific study, not an entire project. Justifiable concerns exist related to the costs of data sharing. Preparing data for uploading, maintaining data archives, and communicating with researchers who request assistance from original research teams to understand the data involve financial and time costs that will be borne by institutions of higher education, governmental agencies, and individual researchers. To ensure costs and other issues that will surely arise with the implementation of data sharing are addressed in a comprehensive manner, the special education research community—researchers, universities, funders, publishers, advocacy organizations, and others—need to respond collectively. By establishing norms across the discipline, no single group (a specific journal, for example) will risk incurring greater scrutiny or costs than any other.

Preprints

Open access to outcomes ensures that research findings are feely available to all who are interested rather than being accessible to only those who can afford to pay or are at institutions that can pay for subscriptions. Emphasis on the open access movement has spurred some journals to move from subscription-based to submission- or publication-fee business models.

Another emerging alternative is to post openly licensed versions of the paper on preprint and postprint services that can be freely accessed (Berg et al., 2016). A preprint is a version of the article shared prior to publication at a journal. A postprint is a manuscript version of the final article without the journal's formatting. The arXiv for physics and allied sciences (https://arxiv.org) started in 1991 and, with >1.3 million papers using the service for rapid, open sharing of research, it has become a pervasive norm in the discipline. In the last few years, dozens of similar services have emerged for various disciplines such as SocArXiv (http://socarxiv.org/) for social sciences (see http://osf.io/preprints/ for an aggregate search of many preprint and postprint services).

Preregistration

Preregistration is the act of declaring publicly in advance how a study will be conducted and how data will be analyzed. That is, researchers specify a protocol for how the data will be collected and treated once they are observed. Preregistration helps mitigate the file-drawer problem (Rosenthal, 1979) by making all research, whether it is ultimately published or not, discoverable. When studies are pre-registered, meta-analysts can more easily discover all research on a topic and better estimate whether the published results provide biased evidence.

Preregistration of analysis plans also addresses the quality of statistical inferences made in research. Special education, like many other fields, often uses statistical inference to test hypotheses and advance knowledge. The tools of statistical inference, such as null hypothesis significance testing and associated *p*-values, are most properly used in confirmatory analysis in which the hypotheses and analysis plans are specified before observing the data (Nosek et al., 2017). This preserves the "diagnosticity" of the statistical inferences and, as long as all preregistered analyses are reported, reduces the deleterious effects of *p*-hacking and selective

reporting (Wagenmakers et al., 2012). That is, *p*-values lose their inferential validity in exploratory analysis when researchers make analytic decisions after observing and analyzing the data. Preregistration of analysis plans solves this problem by making a clear distinction between analyses that were planned a priori and those that emerge in exploration of the dataset. Preregistration has had positive effects in other fields. Kaplan and Irvin (2015) reported that after the National Heart, Blood, and Lung Institute began requiring preregistration in 2000, the proportion of large-scale RCTs funded by the institute reporting null findings increased significantly—perhaps due to decreased flexibility in data analysis and curtailed exploratory analyses.

A common concern related to preregistration is that it may restrict researchers' freedom to conduct exploratory analyses, which can lead to important insights and advances. However, preregistration does not prohibit or even discourage exploratory analysis. Rather, preregistration simply requires that exploratory analysis be clearly identified as such and not treated as if it was confirmatory. Exploratory analysis is vitally important for discovery and generating new hypotheses, but mistaking exploratory analysis for confirmatory tests can dramatically increase the likelihood of false positives and faulty inference (Nosek et al., 2017).

Preregistration is well established in the clinical sciences, where it is often referred to as prospective trial registration. Most registries include a standard form to be completed by the researcher, which becomes the basis of the preregistration. Alternatively, researchers can complete one of several templates prior to uploading to a registry (e.g., Brandt et al., 2014; van't Veer & Giner-Sorolla, 2016; or those maintained by the Center for Open Science, https://osf.io/zab38/wiki/home/, or Project TIER, https://www.projecttier.org/tier-classroom/oslpt-preregistration-template/).

Registered Reports

Preregistration is new to most special education researchers, and the change in workflow to planning all analyses in advance can be a barrier to adoption. Registered Reports offers a mechanism to achieve the benefits of preregistration combined with researchers' key incentive: publication. Registered Reports is a publishing format in which studies undergo peer review in two stages (Chambers, Feredoes, Muthukumaraswamy, & Etchell, 2014). The initial review occurs before the study is conducted, based on reviews of preregistered study plans. At this stage, papers can be rejected or accepted in principle based on the quality of the preregistered study plans (e.g., importance of the research questions, rationale for the hypotheses, clarity and soundness of methods, presence of quality checks) and incorporation of recommendations from the reviewers and editors. Papers with in-principle acceptance undergo a second round of review after the study is completed. Crucially, evaluation at the second stage only includes examining whether the conclusions are justified by the data, whether the study adhered to preregistered plans, and whether any exploratory analyses not specified in the preregistered plans are clearly identified and justified. Evaluations of novelty, direction, or statistical significance of findings cannot affect final publication. Thus, publication is not contingent on obtaining novel or positive results. Rather, publication decisions are based on asking important research questions and applying highly effective methods to test those questions. In Registered Reports, preregistration is a natural step in the review process, and reviewers can prospectively inform the research design rather than just pointing out what was done wrong after the study is complete. In addition to increasing the robustness of the observed research results by providing feedback on the preregistered study plans, Registered Reports address possible prejudice against null results by making initial decisions for publication prior to knowing the results of the research (Nosek &

Lakens, 2014). Registered Reports are offered at 108 journals as of June, 2018 (see https://cos.io/rr for a current list). See Chambers et al. (2014) for responses to common concerns about Registered Reports.

Open Science in Special Education

Open science has been pioneered in other disciplines, and special education has yet to adopt these practices on a discipline-wide basis. In this section, we discuss why special education is especially likely to benefit from open science reforms and describe how open science might be applied in special education.

Why Special Education?

We propose that special education is in a good position to adopt and benefit from open science reforms. Special education has a proud tradition of improving the trustworthiness of its research base. By making the research process more transparent, open, and reproducible, open science can serve as a next step in heightening the trustworthiness of the research base in special education, which serves as the ostensible basis for practice and policy in the field. Special education is a highly applied field in which practitioners can often employ the findings of research directly in their instructional interactions with students with disabilities. Accordingly, adopting open science reforms that heighten the validity of research findings has the potential to positively influence the educational opportunities and outcomes of children and youth with disabilities. Moreover, with its emphasis on shared data and open access, open science makes scientific progress more efficient by speeding the pace at which scientific knowledge is traditionally accumulated and translated into practice.

Despite the importance of using highly effective, evidence-based practices in special education and educators' stated desires to use research to select effective practices (Whitehurst,

2003), a gap between research and practice persists (Cook & Farley, in press). Observational and survey research shows that some ineffective practices are commonly implemented, whereas some highly effective, research-based practices are seldom applied (e.g., Gable, Tonelson, Sheth, Wilson, & Park, 2012; Lloyd, Forness & Kavale, 1998; McKenna, Shin, & Ciullo, 2015). Though many factors likely underlie the research-to-practice gap, practitioners' mistrust of research appears to be an important obstacle to bridging the gap (Boardman, Arguelles, Vaughn, Hughes, & Klingner, 2005). Openness promotes confidence and trust, whereas secrecy breeds distrust and suspicion (Cottey, 2010). Thus, in addition to improving the validity of the research base, implementing open science reforms may be a contributing factor in beginning to bridge the research-to-practice gap in special education.

Application of Open Science to Special Education

Applying open science in special education will require that researchers, editors, funders, publishers, and others adopt practices and procedures that may be unfamiliar and uncomfortable. Nonetheless, organizations that represent researchers and publication outlets in education, such as the American Educational Research Association (AREA), have already begun to implement open science principles. AERA committed to a policy only to publish studies in its journals, "when the data, methods used in the analysis, and materials used to conduct the research are clearly and precisely documented and made available" (AERA, 2017, p. 1). Because open science will be increasingly applied in the field of education, special education researchers and journals should also adopt open science reforms or risk their research being viewed as comparably less trustworthy. Instead of simply following along, special educators could take the lead in implementing open science. Undertaking efforts to improve the research enterprise to enhance policy and practice is a core value in special education and, because of the field's

relatively small size and commitment to evidence-based practices, special education scholars are well positioned to move rapidly in adopting open science principles. The primary payoff, of course, is an improved evidence base that provides a sound basis for highly effective instruction for individuals with disabilities.

Accomplishing this task will not require a herculean effort. Practices such as preregistering studies, making data and codes freely available, and providing article preprints will no doubt alter the work routines for researchers. However, we do not believe open science reforms entail fundamental changes to how research is conducted in special education, and we are sanguine about the existence of guidelines and incentives to facilitate the adoption of open science principles. For example, the Transparency and Openness Promotion (TOP) Guidelines provide a policy framework for journals, funders, and institutions to increase transparency and credibility of research (Nosek et al., 2015). TOP Guidelines are comprised of eight standards: data citation; data, materials, and analytical code transparency; design and analysis transparency with reporting guidelines; preregistration of studies and preregistration of analysis plans; and publishing replication studies. Journals, funders, or institutions can adopt one, some, or all of the standards, and each standard has three levels of stringency for application. For most of the standards, the levels correspond to disclosure, requirement, and verification. As of June 2018, most major publishers have become signatories to the guidelines and more than 800 journals have completed the implementation process for updating their policies.

Implementing a badge system can also incentivize researchers to adopt open science practices. Dozens of journals, including those in the social-behavioral sciences, have adopted badges to acknowledge open data, open materials, and preregistration (Kidwell et al., 2016). Badges that appear on an article signal that the authors met openness standards and are an easy

way to shift norms by making evident when others engage in valued behaviors and providing a small incentive for doing so. Offering Open Science Badges has been associated with an increase in data sharing (Kidwell et al., 2016) in the absence of any mandate to do so. For example, *Psychological Science* was the first journal to adopt the open badges. For the two years prior to adopting badges, 3% of the articles reported having open data; 1.5 years after adoption, 39% of the articles reported having open data (Kidwell et al., 2016).

Over time, we believe that open science practices will become the new normal in special education research. Just as special education researchers have met calls for increased methodological rigor, they can incorporate open science practices into their research to heighten the trustworthiness of their findings. Beyond specific changes in practice, effective adoption of open science will require a cultural shift in special education research and publication (see Casadevall & Fang, 2012). Incentives in the field must change to reward researchers for opening their research process and sharing their data. Replication studies and the publication of null findings must be valued in a similar manner to studies of novel interventions that produce statistically significant findings. This cultural shift will require changes at multiple levels—from altering criteria used by university promotion and tenure committees to changing publication outlets' processes and funding agencies' priorities.

Conclusion

Dichotomous thinking, or "seeing the world in neatly set dichotomies, such as successful/unsuccessful, effective/ineffective, and White/Black" (Rodriguez, 2001, p. 1116), can oversimplify and distort perceptions of nuanced reality. We are not arguing that previously conducted research in special education is untrustworthy because it did not incorporate open science, or that adopting elements of open science is a panacea that will automatically confer

trustworthiness. Nonetheless, by making questionable research practices easier to avoid, detect, and correct, the research community can nudge the research base in special education toward greater trustworthiness.

Perhaps just as important as the potential for nudging the research base in special education toward heightened validity, open science might also help to engender greater confidence in and adoption of research-based practices and policies among practitioners and other stakeholders. Higgins (2016) suggested that society is entering a post-truth age, in which mistruths are so common and difficult to identify that people give up trying. The conflation of science and other, less systematic ways of knowing have likely been exacerbated by reports of scientific misconduct, study retractions, and inappropriate publishing behaviors (e.g., Etchells & Chambers, 2015; Godlee, Smith, & Marcovitch, 2011). Open science provides a path to help rectify mistrust in scientific research. By opening the figurative books on the research process, open science can help to foster greater confidence among special education stakeholders that research findings are the product of transparent, open, and replicable science, and therefore worthy of trust.

References

Anderson, M. S., Ronning, E. A., De Vries, R., & Martinson, B. C. (2007). The perverse effects of competition on scientists' work and relationships. *Science and Engineering Ethics*, *13*, 437-461. doi: 10.1007/s11948-007-9042-5

American Education Research Association (2017). AERA data sharing and archiving policy for articles published in AERA journals: Revised working draft. *American Education Research Association*, Washington, DC.

Banerjee, R., Movahedazarhouligh, S., Millen, K., & Luckner, J. L. (2018). Building evidence in early childhood special education: A systematic review of replication intervention studies. *Topics in Early Childhood Special Education*, *37*, 246-256. doi: 10.1177/0271121417748197

Berg, J. M., Bhalla, N., Bourne, P. E., Chalfie, M., Drubin, D. G., Fraser, J. S., ... & King, S. (2016). Preprints for the life sciences. *Science*, *352*, 899-901. doi: 10.1126/science.aaf9133

Boardman, A. G., Arguelles, M. E., Vaughn, S., Hughes, M. T., & Klingner, J. (2005). Special education teachers' views of research-based practices. *Journal of Special Education, 39*, 168-180. doi:10.1177/00224669050390030401

Brandt, M. J., IJzerman, H., Dijksterhuis, A., Farach, F. J., Geller, J., Giner-Sorolla, R., … van 't Veer, A. (2014). The replication recipe: What makes for a convincing replication? *Journal of Experimental Social Psychology, 50*, 217–224. doi: 10.1016/j.jesp.2013.10.005

Cain, L., DiCarlo, L. M., Kvaraceus, W. C., Johnson, G. O., Lowenfeld, B., Meyer, L., … Kirk, S. A. (1952). The ICEC research committee report. *Exceptional Children, 19*, 81-83. doi: 10.1177/001440295201900206

Camerer, C. F., Dreber, A., Forsell, E., Ho, T.-H., Huber, J., Johannesson, M., … Wu, H. (2016). Evaluating replicability of laboratory experiments in economics. *Science, 351*, 1433–1436. doi: 10.1126/science.aaf0918

Carnine, D. (1997). Bridging the research-to-practice gap. *Exceptional Children*, *63*, 513-521. doi: 10.1177/001440299706300406

Casadevall, A., & Fang, F. C. (2012). Reforming science: Methodological and cultural reforms. *Infection and Immunity, 80*, 891–896. doi:10.1128/IAI.06183-11

Chambers, C., Feredoes, E., D. Muthukumaraswamy, S. J., & Etchells, P. (2014). Instead of "playing the game" it is time to change the rules: Registered Reports at AIMS Neuroscience and beyond. *AIMS Neuroscience, 1*, 4–17. doi: 10.3934/Neuroscience.2014.1.4

Chow, J., & Ekholm, E. (2018). Do published studies yield larger effect sizes than unpublished studies in education and special education? A meta-review. *Educational Psychology Review*. Advance online publication. doi: 10.1007/s10648-018-9437-7

Clarke, S., Zakszeski, B. N., & Kern, L. (2018). Trends in JPBI publications, 1999–2016. *Journal of Positive Behavior Interventions*, *20*, 6-14. doi: 10.1177/1098300717722359

Cook, B. G., Collins, L. W., Cook, S. C., & Cook, L. H. (2016). A replication by any other name: A systematic review of replicative intervention studies. *Remedial and Special Education*, *37*, 223-234. doi: 10.1177/0741932516637198

Cook, B. G., & Farley, C. (in press). The research-to-practice gap in special education, In D. Bateman, J. Cline, & M. L. Yell (Eds.), *Current trends and legal issues in special education*. Thousand Oaks, CA: Corwin.

Cook, B. G., & Odom, S. L. (2013). Evidence-based practices and implementation science in special education. *Exceptional Children*, *79*, 135-144. doi: 10.1177/001440291307900201

Cook, B. G., & Therrien, W. J. (2017). Null effects and publication bias in special education research. *Behavioral Disorders, 42*, 149-158. doi: 10.1177/0198742917709473

Cottey, A. (2010). Openness, confidence and trust in science and society. *The International Journal of Science in Society, 1*, 185-194. doi: 10.18848/1836-6236/CGP/v01i04/51492

Crockett, J. B. (2004). Taking stock of science in the schoolhouse: Four ideas to foster effective instruction. *Journal of Learning Disabilities, 37,* 189-199. doi: 10.1177/00222194040370030201

Dorch, B. (2012, July 5). On the citation advantage of linking to data. Retrieved from https://hal-hprints.archives-ouvertes.fr/hprints-00714715/document

Ebersole, C. R., Atherton, O. E., Belanger, A. L., Skulborstad, H. M., Allen, J. M., Banks, J. B., … Nosek, B. A. (2016). Many Labs 3: Evaluating participant pool quality across the academic semester via replication. *Journal of Experimental Social Psychology, 67*, 68–82. doi: 10.1016/j.jesp.2015.10.012

Etchells, P., & Chambers, C. (2015). The games we play: A troubling dark side in academic publishing. *The Guardian*. Retrieved from https://www.theguardian.com/science/head-quarters/2015/mar/12/games-we-play-troubling-dark-side-academic-publishing-matson-sigafoos-lancioni

Fanelli, D. (2010). “Positive” results increase down the hierarchy of the sciences. *PLoS ONE, 5*(4), e10068. doi:10.1371/journal.pone.0010068

Ferguson, C. J., & Heene, M. (2012). A vast graveyard of undead theories: Publication bias and psychological science’s aversion to the null. *Perspectives on Psychological Science, 7*, 555–561. doi: https://doi.org/10.1177/1745691612459059

Franco, A., Malhotra, N., & Simonovits, G. (2014). Publication bias in the social sciences: Unlocking the file drawer. *Science, 345*, 1502–1505. doi:10.1126/science.1255484

Frequently Asked Questions (FAQs) on Data Sharing. (2003). Retrieved June 12, 2018, from https://grants.nih.gov/grants/policy/data_sharing/data_sharing_faqs.htm#898

Frith, G. H. (1981). “Advocate” vs.“professional employee”: A question of priorities for special educators. *Exceptional Children, 47,* 486-492. doi: 10.1177/001440298104700701

Gable, R. A., Tonelson, S. W., Sheth, M., Wilson, C., & Park, K. L. (2012). Importance, usage, and preparedness to implement evidence-based practices for students with emotional disabilities: A comparison of knowledge and skills of special education and general education teachers. *Education and Treatment of Children*, *35*, 499-520. doi: 10.1353/etc.2012.0030

Gage, N. A., Cook, B. G., & Reichow, B. (2017). Publication bias in special education meta-analyses. *Exceptional Children, 83,* 428-445. doi: 10.1177/0014402917691016

Gersten, R., Fuchs, L. S., Compton, D., Coyne, M., Greenwood, C., & Innocenti, M. S. (2005). Quality indicators for group experimental and quasi-experimental research in special education. *Exceptional Children*, *71*, 149-164. doi: 10.1177/001440290507100202

Gilmore, R. O., Kennedy, J. L., & Adolph, K. E. (2018). Practical solutions for sharing data and materials from psychological research. *Advances in Methods and Practices in Psychological Science, 1*, 121–130. doi: https://doi.org/10.1177/2515245917746500

Giner-Sorolla, R. (2012). Science or art? How aesthetic standards grease the way through the publication bottleneck but undermine science. *Perspectives on Psychological Science, 7*, 562–571. doi: 10.1177/1745691612457576

Giordano, G. (2007). *American special education: A history of early political advocacy*. New York, NY: Peter Lang.

Godlee, F., Smith, J., & Marcovitch, H. (2011). Wakefield's article linking MMR vaccine and autism was fraudulent. *British Medical Journal, 342*, 64-66. doi: 10.1136/bmj.c7452

Goodman, S. N., Fanelli, D., & Ioannidis, J. P. A. (2016). What does research reproducibility mean? *Science Translational Medicine, 8*, 341. doi: 10.1126/scitranslmed.aaf5027

Greenwald, A. G. (1975). Consequences of prejudice against the null hypothesis. *Psychological Bulletin, 82*, 1–20. doi: https://doi.org/10.1037/h0076157

Gunsalus, C. K., & Robinson, A. D. (2018). Nine pitfalls of research misconduct. *Nature, 557*, 297-299. doi: https://doi.org/10.1038/d41586-018-05145-6

Henneken, E. A., & Accomazzi, A. (2011). Linking to data - effect on citation rates in astronomy. ArXiv:1111.3618 [Astro-Ph]. Retrieved from http://arxiv.org/abs/1111.3618

Higgins, K. (2016). Post-truth: a guide for the perplexed. *Nature News*, *540*(7631). doi: 10.1038/540009a

Horner, R. H., Carr, E. G., Halle, J., McGee, G., Odom, S., & Wolery, M. (2005). The use of single-subject research to identify evidence-based practice in special education. *Exceptional Children*, *71*, 165-179. doi: 10.1177/001440290507100203

Ioannidis, J. P. (2012). Why science is not necessarily self-correcting. *Perspectives on Psychological Science*, *7*, 645-654. doi: 10.1177/1745691612464056

John, L. K., Loewenstein, G., & Prelec, D. (2012). Measuring the prevalence of questionable research practices with incentives for truth telling. *Psychological Science, 23*, 524–532. doi:10.1177/0956797611430953

Kaplan, R. M., & Irvin, V. L. (2015). Likelihood of null effects of large NHLBI clinical trials has increased over time. *PLoS One, 10*(8), e0132382. doi: 10.1371/journal.pone.013238

Kidwell, M. C., Lazarević, L. B., Baranski, E., Hardwicke, T. E., Piechowski, S., Falkenberg, L. S., ... & Errington, T. M. (2016). Badges to acknowledge open practices: A simple, low-cost, effective method for increasing transparency. *PLoS Biology, 14*(5), e1002456. doi: 10.1371/journal.pbio.1002456

Kittleman, A., Gion, C., Horner, R. H., Levin, J. L., & Kratochwill, T. R. (2018). Establishing journalistic standards for the publication of negative results. *Remedial and Special Education*. Advance online publication. doi: 10.1177/0741932517745491

Klein, R. A., Ratliff, K. A., Vianello, M., Adams, R. B., Bahník, Š., Bernstein, M. J., … Nosek, B. A. (2014). Investigating variation in replicability. *Social Psychology, 45*(3), 142–152. doi: 10.1027/1864-9335/a000178

LeBel, E. P., McCarthy, R., Earp, B., Elson, M., & Vanpaemel, W. (in press). A unified framework to quantify the credibility of scientific findings. *Advances in Methods and Practices in Psychological Science*. Preprint retrieved from https://psyarxiv.com/uwmr8

Landrum, T. J., Cook, B. G., Tankersley, M., & Fitzgerald, S. F. (2002). Teacher perceptions of the trustworthiness, useability, and accessibility of information from different sources. *Remedial and Special Education, 23*, 42-8. doi: 10.1177%2F074193250202300106

Lemons, C. J., King, S. A., Davidson, K. A., Berryessa, T. L., Gajjar, S. A., & Sacks, L. H. (2016). An inadvertent concurrent replication: Same roadmap, different journey. *Remedial and Special Education*, *37*, 213-222. doi: 10.1177/0741932516631116

Levenstein, M. C., & Lyle, J. A. (2018). Data: Sharing is caring. *Advances in Methods and Practices in Psychological Science, 1*, 95–103. doi: 10.1177/2515245918758319

Lloyd, J. W., Forness, S. R., & Kavale, K. A. (1998). Some methods are more effective than others. *Intervention in School and Clinic, 33,* 195-200. doi: https://doi.org/10.1177/105345129803300401

Makel, M. C., & Plucker, J. A. (2014). Facts are more important than novelty: Replication in the education sciences. *Educational Researcher, 43,* 304-316. doi: 10.3102/0013189X14545513

Makel, M. C., Plucker, J. A., Freeman, J., Lombardi, A., Simonsen, B., & Coyne, M. (2016). Replication of special education research: Necessary but far too rare. *Remedial and Special Education*, *37*, 205-212. doi: 10.1177/0741932516646083

Makel, M., Plucker, J., & Hegarty, B. (2012). Replications in psychology research: How often do they really occur? *Perspectives on Psychological Science, 7*, 537–542. doi:10.1177/1745691612460688

Masuzzo, P., & Martens, L. (2017). Do you speak open science? Resources and tips to learn the language. *PeerJ Preprints*, 1-22. doi: 10.7287/peerj.preprints.2689v1

McKenna, J. W., Shin, M., & Ciullo, S. (2015). Evaluating reading and mathematics instruction for students with learning disabilities: A synthesis of observation research. *Learning Disability Quarterly*, *38*, 195-207. doi: 10.1177/0731948714564576

McKiernan, E. C., Bourne, P. E., Brown, C. T., Buck, S., Kenall, A., Lin, J., ... & Spies, J. R. (2016). How open science helps researchers succeed. *Elife, 5*, e16800. doi: 10.7554/eLife.16800

Merton, R. (1942). *The normative structure of science*. Reprinted in *The sociology of science: Theoretical and empirical investigations* (1973). Chicago, IL: University of Chicago Press.

Meyer, M. N. (2018). Practical tips for ethical data sharing. *Advances in Methods and Practices in Psychological Science*, *1*, 131-144. doi: 10.1177/2515245917747656

Miguel, E., Camerer, C., Casey, K., Cohen, J., Esterling, K. M., Gerber, A., … Laitin, D. (2014). Promoting transparency in social science research. *Science, 343*, 30–31. doi: 10.1126/science.1245317

Mitroff, I. I. (1974). Norms and counter-norms in a select group of the Apollo moon scientists: A case study of the ambivalence of scientists. *American Sociological Review*, *39*, 579-595.

Molloy, J. C. (2011). The open knowledge foundation: Open data means better science. *PLoS biology*, *9*(12), e1001195. doi: 10.1371/journal.pbio.1001195

Munafò, M. R., Nosek, B. A., Bishop, D. V. M., Button, K. S., Chambers, C. D., Percie du Sert, N., … Ioannidis, J. P. A. (2017). A manifesto for reproducible science. *Nature Human Behaviour, 1*(1), 0021. doi: https://doi.org/10.1038/s41562-016-0021

Nosek, B. A., Alter, G., Banks, G. C., Borsboom, D., Bowman, S. D., Breckler, S. J., ... Yarkoni, T. (2015). Promoting an open research culture. *Science, 348,* 1422-1425. doi: 10.1126/science.aab2374

Nosek, B. A., & Bar-Anan, Y. (2012): Scientific utopia: I. Opening scientific communication. *Psychological Inquiry: An International Journal for the Advancement of Psychological Theory, 23,* 217-243. doi: 10.1080/1047840X.2012.692215

Nosek, B. A., & Errington, T. M. (2017). Making sense of replications. *ELife, 6*. doi: https://doi.org/10.7554/eLife.23383

Nosek, B. A., & Lakens, D. (2014). Registered reports. *Social Psychology, 45*(3), 137–141. doi: https://doi.org/10.1027/1864-9335/a000192

Nosek, B. A., Spies, J. R., & Motyl, M. (2012). Scientific utopia: II. Restructuring incentives and practices to promote truth over publishability. *Perspectives on Psychological Science, 7,* 615–631. doi: 10.1177/1745691612459058

Odom, S. L., Brantlinger, E., Gersten, R., Horner, R. H., Thompson, B., & Harris, K. R. (2005). Research in special education: Scientific methods and evidence-based practices. *Exceptional Children*, *71*, 137-148. doi: 10.1177/001440290507100201

Open Science Collaboration. (2015). Estimating the reproducibility of psychological science. *Science*, *349*(6251), aac4716. doi: 10.1126/science.aac4716

Piwowar, H. A., Day, R. S., & Fridsma, D. B. (2007). Sharing detailed research data is associated with increased citation rate. *PLOS ONE, 2*(3), e308. doi: 10.1371/journal.pone.0000308

Piwowar, H. A., & Vision, T. J. (2013). Data reuse and the open data citation advantage. *PeerJ, 1*, e175. doi: 10/f3mn68

Pontika, N., Knoth, P., Cancellieir, M., & Pearce, S. (2015). Fostering open science to research using a taxonomy and an eLearning portal. Paper presented at *iKnow: 15th International Conference on Knowledge Technologies and Data Driven Business*, Graz, Austria. Retrieved from http://oro.open.ac.uk/44719/

Randall, D., & Welser, C. (2018). *The irreproducibility crisis of modern science: Causes, consequences, and the road to reform.* National Association of Scholars. Retrieved from https://www.nas.org/images/documents/irreproducibility_report/NAS_irreproducibilityReport.pdf

Rodriguez, A. J. (2001). From gap gazing to promising cases: Moving toward equity in urban education reform. *Journal of Research in Science Teaching*, *38*, 1115-1129. doi: 10.1002/tea.10005

Rosenthal, R. (1979). The "file drawer problem" and tolerance for null results. *Psychological Bulletin, 86*, 638–641. doi: 10.1037/0033-2909.86.3.638

Shadish, W. R., Zelinsky, N. A., Vevea, J. L., & Kratochwill, T. R. (2016). A survey of publication practices of single-case design researchers when treatments have small or large effects. *Journal of Applied Behavior Analysis, 49*, 656–673. doi:10.1002/jaba.308

Sham, E., & Smith, T. (2014). Publication bias in studies of an applied behavior-analytic intervention: An initial analysis. *Journal of Applied Behavior Analysis, 47*, 663–678. doi:10.1002/jaba.146

Shavelson, R. J., & Towne, L., (Eds). (2002). *Scientific research in education.* Washington, DC: National Academy Press.

Silberzahn, R., Uhlmann, E. L., Martin, D. P., Anselmi, P., Aust, F., Awtrey, E. C., … Nosek, B. A. (2017, September 21). Many analysts, one dataset: Making transparent how variations

in analytical choices affect results. *Zurich Open Repository and Archive*. doi: 10.17605/OSF.IO/QKWST

Simmons, J. P., Nelson, L. D., & Simonsohn, U. (2011). False-positive psychology: Undisclosed flexibility in data collection and analysis allows presenting anything as significant. *Psychological Science, 22*, 1359-1366. doi:10.1177/0956797611417632

Slavin, R. E. (2002). Evidence-based education policies: Transforming educational practice and research. *Educational Researcher, 31*(7)*,* 15-21. doi: 10.3102/0013189X031007015

Sterling, T. D. (1959). Publication decisions and their possible effects on inferences drawn from tests of significance--Or vice versa. *Journal of the American Statistical Association, 54*(285), 30. doi: 10.2307/2282137

Stodden, V. (2010). The scientific method in practice: Reproducibility in the computational sciences. *MIT Sloan Research Paper No. 4773-10.* Retrieved from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1550193

Tenopir, C., Allard, S., Douglass, K., Aydinoglu, A. U., Wu, L., Read, E., … Frame, M. (2011). Data sharing by scientists: Practices and perceptions. *PLoS ONE, 6*(6), e21101. doi: https://doi.org/10.1371/journal.pone.0021101

Therrien, W. J., & Cook, B. G. (2018). Null effects and publication bias in learning disabilities research. *Learning Disabilities Research & Practice*, *33*, 5-10. doi: 10.1111/ldrp.12163

Therrien, W. J., Mathews, H. M., Hirsch, S. E., & Solis, M. (2016). Progeny review: An alternative approach for examining the replication of intervention studies in special education. *Remedial and Special Education*, *37*, 235-243. doi: 10.1177/0741932516646081

Travers, J. C., Cook, B. G., Therrien, W. J., & Coyne, M. D. (2016). Replication research and special education. *Remedial and Special Education*, *37*, 195-204. doi: 10.1177/0741932516648462

van ’t Veer, A. E., & Giner-Sorolla, R. (2016). Pre-registration in social psychology—A discussion and suggested template. *Journal of Experimental Social Psychology, 67*, 2–12. doi: 10.1016/j.jesp.2016.03.004

Wagenmakers, E. J., Wetzels, R., Borsboom, D., van der Maas, H. L., & Kievit, R. A. (2012). An agenda for purely confirmatory research. *Perspectives on Psychological Science, 7*, 632-638. doi: 10.1177/1745691612463078

Whitehurst, G. J. (2003). The Institute of Education Sciences: New wine, new bottles. Paper presented at the annual conference of the American Educational Research Association, Los Angeles, CA. Retrieved from https://ies.ed.gov/director/pdf/2003_04_22.pdf

Wilkinson, M. D., Dumontier, M., Aalbersberg, Ij. J., Appleton, G., Axton, M., Baak, A., … Mons, B. (2016). The FAIR Guiding Principles for scientific data management and stewardship. *Scientific Data, 3*, 160018. doi: 10.1038/sdata.2016.18

Yell, M. L., Rogers, D., & Rogers, E. L. (1998). The legal history of special education: What a long, strange trip it's been! *Remedial and Special Education, 19,* 219-228. doi: 10.1177/074193259801900405

Zigmond, N. (1997). Educating students with disabilities: The future of special education. In J. W. Lloyd, E. J. Kameenui, & D. Chard (Eds.). *Issues in educating students with disabilities* (pp. 325-342). Mahwah, NJ: Erlbaum.