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Actionable recommendations for narrowing the science-practice gap in open science

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ABSTRACT

Efforts to promote open-science practices are, to a large extent, driven by a need to reduce questionable research practices (QRPs). There is ample evidence that QRPs are corrosive because they make research opaque and therefore challenge the credibility, trustworthiness, and usefulness of the scientific knowledge that is produced. A literature based on false-positive results that will not replicate is not only scientifically misleading but also worthless for anyone who wants to put knowledge to use. So, a question then arises: Why are these QRPs still so pervasive and why do gatekeepers of scientific knowledge such as journal editors, reviewers, funding-agency panel members, and board members of professional organizations in charge of journal policies not seem to be taking decisive actions about QRPs? We address these questions by using a science-practice gap analogy to identify the existence of a *science-practice gap in open science*. Specifically, although there is abundant research on how to reduce QRPs, many gatekeepers are not adopting this knowledge in their practices. Drawing upon the literatures on the more general science-practice gap and QRPs, we offer 10 actionable recommendations for narrowing the specific science-practice gap in open science. Our recommendations require little effort, time, and financial resources. Importantly, they are explicit about the resulting benefits for the various research-production stakeholders (i.e., authors and gatekeepers). By translating findings on open-science research into actionable recommendations for "practitioners of research", we hope to encourage more transparent, credible, and reproducible research that can be trusted and used by consumers of that research.

1. Introduction

Openness and transparency are critical for all scientific fields (Nosek et al., 2015). To a large extent, efforts to promote open science are driven by a need to reduce questionable research practices (QRPs) (Banks, Rogelberg, Woznyj, Landis, & Rupp, 2016c). Examples of QRPs include HARKing (i.e., hypothesizing after results are known; Kerr, 1998; Murphy & Aguinis, 2019), proposing unnecessarily complex causal models (Saylors & Trafimow, in press), selective reporting of hypotheses (O'Boyle, Banks, & Gonzalez-Mule, 2017), as well as inappropriately reporting degrees of freedom (Cortina, Green, Keeler, & Vandenberg, 2017), fit indices (Williams, O'Boyle, & Yu, 2020), *p*-values (John, Loewenstein, & Prelec, 2012), and insufficient transparency in the general reporting of research results (Aguinis, Ramani, & Alabduljader, 2018; Aguinis & Solarino, 2019). Taken together, these QRPs make research opaque, preclude replicability, and challenge the credibility, trustworthiness, and usefulness of the scientific knowledge that is produced. QRPs are a major concern for open-science efforts because a literature based on false-positive results that will not replicate is not only scientifically misleading, but also worthless for anyone who wants to put knowledge to use (Ioannidis, 2005; Starbuck, 2016).

The existence and detrimental effects of QRPs are no longer novel. Over the past few years, a vast amount of knowledge has been created regarding QRPs that spans disciplines (for reviews see Aguinis et al., 2018; Banks et al., 2019; Banks, O'Boyle et al., 2016, Banks, Rogelberg et al., 2016; Fanelli, 2009; Fanelli, 2012; Nosek et al., 2015; Song et al., 2010). In fact, entire research programs on QRPs are currently carried out in management (Bedeian, Taylor, & Miller, 2010), sociology (Gerber & Malhotra, 2008b), political science (Gerber & Malhotra, 2008a), psychology (John et al., 2012; Simmons, Nelson, & Simonsohn, 2011), and many other fields (Fanelli, 2010, 2012; Pigott, Valentine, Polanin, Williams, & Canada, 2013). In sum, there is a substantial amount of knowledge that has been generated about QRPs, their pervasiveness, and their detrimental effects on the credibility and trustworthiness of research. A question that arises then is, why are QRPs still so pervasive, given the abundant literature about these issues? Also, why do stakeholders of research, including authors as well as gatekeepers of scientific knowledge, such as journal editors, reviewers, funding-agency panel members, and board members of professional organizations in charge of journal policies not seem to be taking decisive actions about QRPs?

We use the science-practice gap that is often discussed in applied sciences as an analogy to identify the existence of a *science-practice gap in open science*, which we offer as an explanation for why the open-

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science movement is yet to be embraced on a global and massive scale. Importantly, we offer actionable recommendations to narrow this gap. In this process, we draw upon past reviews of the science-practice gap in management and related fields (Aguinis et al., 2017; Banks, Pollack et al., 2016; Bansal, Bertels, Ewart, MacConnachie, & O'Brien, 2012; Cascio & Aguinis, 2008; Shapiro, Kirkman, & Courtney, 2007).

2. The science-practice gap in open science

The science-practice gap refers to a disconnect between "the knowledge that academics are producing and the knowledge that practitioners are consuming" (Cascio & Aguinis, 2008; p. 1062). The science-practice gap has been recognized as a grand challenge in the 21st century because it means that practitioners fail to adopt evidence-based practices (Banks, Pollack et al., 2016). We argue that there is a science-practice gap specifically in the open-science domain. On one hand, there is ample knowledge created by researchers in the open-science domain about how to minimize QRPs, increase transparency, and accelerate the dissemination of knowledge. On the other hand, "practitioners of research" in the knowledge-production process are not adopting practices documented by recent knowledge produced by researchers in this domain. Practitioners of research include authors but also gatekeepers, such as journal editors, reviewers, funding-agency panel members, and board members of professional organizations in charge of journal policies. In some cases, distinctions among these roles can be blurry because, for example, an author may also serve as an editor and as an elected official on the board of a professional organization. Nevertheless, all of these stakeholders are "practitioners of research" given their active involvement in the knowledge-creation process.

Similar to Aguinis et al. (2018), we use motivation theory to suggest that a key reason for the existence of a science-practice gap in open science is a hesitation to implement practices because the perceived costs of doing so may outweigh the perceived benefits. For example, from the perspective of authors, they may consider research practices that are most likely to lead to the highly desired outcome of publishing a manuscript in a prestigious journal. In an example specifically about outlier management, would dropping outliers without mentioning it lead to results "looking better" (e.g., better fit of the data to the hypothesized model) and a greater probability of publication? Or, is it better to disclose outlier-management techniques openly and transparently, leading to improved reproducibility but also possibly to results that may not support the hypotheses (Aguinis et al., 2018, p. 87)? Similarly, from the perspective of a journal editor, which practices are more likely to result in benefits, such as a higher impact factor—an important determinant of inclusion in highly-coveted journal lists (Aguinis, Cummings, Ramani, & Cummings, 2020)? Is it possible that implementing open-access practices unilaterally by a journal is associated with a lower impact factor (Byington & Felps, 2017)?

Based on motivation theory, stakeholders in the scientific-production process may conduct the same cost-benefit analysis as other people when choosing their behaviors. Thus, it is important to consider the motivation of stakeholders and to account for the expected value associated with engaging in open-science practices. That is, what motivates stakeholders to confront institutional challenges and to implement new open-science practices?

Drawing upon past research on how to narrow the general science-practice gap (e.g., Aguinis et al., 2017; Banks, Pollack et al., 2016; Bansal et al., 2012; Cascio & Aguinis, 2008; Shapiro et al., 2007), and benefits associated with doing so, we identify five primary types of approaches to bridge the gap in open science. These are: (1) updating the knowledge-production process, (2) updating knowledge-transfer and knowledge-sharing processes, (3) changing the incentive structure, (4) improving access to training resources, and (5) promoting shared values. We integrate these five general types of approaches with available evidence specific to the open-science literature as well as to the literature on QRPs in management and related fields. Then, we offer 10 actionable recommendations for narrowing the science-practice gap in open science.

Our recommendations can be implemented fairly easily and require little effort, time, and financial resources. They do require a commitment to try something new, however, and they may be uncomfortable initially, especially when others may not be engaging in these actions. However, our recommendations are explicit about the resulting benefits for the various stakeholders in the research-production process. We target our recommendations at researchers, but perhaps more importantly, at gatekeepers who have the power to create and enforce policies regarding standards for published or funded research. Clearly, researchers are more likely to embrace the open-science movement if they are motivated to do so by rewards, the science ecosystem encourages it, and they are better able to publish and secure funding (Aguinis, Joo, & Gottfredson, 2013). Similarly, editors are motivated to enhance the stature and prestige of their journals and funding agencies to serve as conduits of knowledge that is replicable and useful for consumers of research.

We are confident that our recommendations are likely to be successful because they are based on useful lessons from the literature on narrowing the science-practice gap (Albers Mohrman, Lawler, & Associates, 2011). For example, our recommendations are not only about "know what" (i.e., declarative knowledge or knowing about something) but also "know how" (i.e., procedural knowledge or knowing how to do something) (Tenkasi, 2011). Also, as current and former action editors (e.g., *Journal of International Business Studies*, *Organizational Research Methods*, *Journal of Business and Psychology*, *The Leadership Quarterly*) and leaders of professional organizations (e.g., Academy of Management, Society for Industrial and Organizational Psychology), we are very familiar with the kinds of constraints that practitioners of research face (Tenkasi, 2011). Moreover, we frame our recommendations according to the end-users' interests and decision frameworks, and clarify conditions for their use (Rousseau & Boudreau, 2011). In addition, we base our recommendations on knowledge from different disciplines and our recommendations are actionable (Albers Mohrman et al., 2011). Finally, we are also confident that our recommendations are likely to be successful, given that an approach similar to the one we adopt in our article has been successful in narrowing the science-practice gap in domains as varied as goal setting, rewards and leadership, employee engagement, human resources measurement and differentiation, sustainability, positive psychology, work-life integration, and diversity, among others (Lawler & Benson, 2020). This suggests that the changes we propose are not only possible but also are lilely to occur.

3. Recommendations for narrowing the science-practice gap in open science

3.1. Updating the knowledge-production process

Current knowledge-production processes were designed in a previous era and to some extent they are outdated (Nosek & Bar-Anan, 2012; Shapiro et al., 2007). That is, many of the activities in the knowledge-production process precede the advent of the internet and the modern computer. Further, scientific collaboration was largely nonexistent by modern standards and researchers worked in isolation or in small teams (Smith & Master, 2017). As scientific collaboration increases (Fang & Casadevall, 2015), we need to accelerate and revise the knowledge-production process. Hence, our first set of recommendations falls under this category.

Table 1 offers a summary of our recommendations about updating the knowledge-production process to bridge the science-practice gap in open science. As a preview, Table 1 also summarizes anticipated benefits of these recommendations for key stakeholders (e.g., personal benefits), primary decision makers involved in their implementation, and resources needed to overcome potential barriers.

3.2. Recommendation #1: Require preregistration of quantitative and qualitative primary studies

Study preregistration may come in various forms but a commonality

Table 1
Recommendations for narrowing the science-practice gap in open science: Updating the knowledge-production process.

Recommendation	Benefits	Primary decision-makers involved in implementing the recommendations	Resources needed to implement and enforce the recommendations
1. Require preregistration of quantitative and qualitative primary studies	**Definition of the research problem** ● Improved explanation of theoretical and practical problems **Study design** ● Improved planning of study design **Data analyses** ● Improved planning of analyses **Reporting and publishing** ● Improved transparency (e.g., improved differentiation between confirmatory and exploratory analyses)	Editors, funding agencies, and authors	● **Financial resources**: None ● **Time:** 30–60 min of authors' time to preregister using the Open Science Framework and creating an anonymous link for peer-review ● **Additional resources**: None ● **Enforcement**: Editors can desk-reject noncompliant submissions and funding agencies can make funding contingent upon commitment to preregistration
2. Introduce a review track using a registered-report format	**Reporting and publishing** ● Improved credibility of findings and reputations of journals and authors ● Improved evaluation of contributions and methodological rigor	Editors	● **Financial resources**: Standard production costs ● **Time:** 12 months' time of action editor and reviewer ● **Additional resources**: none ● **Enforcement**: None
3. Introduce a second submission track for results-blind reviews	**Reporting and publishing** ● Improved reviewer evaluations that minimize reviewer biases ● Improved transparency	Editors and publishers	● **Financial resources**: Compensation for web developer ● **Time:** 2 months' time of a web developer ● **Additional resources**: Training materials for action editors and reviewers, author guidelines ● **Enforcement**: None
4. Motivate authors to discuss validity threats honestly and precisely to re-invigorate the Discussion sections of papers	**Reporting and publishing** ● Improved credibility and practical usefulness of scientific findings	Editors and authors	● **Financial resources**: None ● **Time:** Possible involvement of specialized reviewers ● **Additional resources**: Training materials for action editors and reviewers; author guidelines ● **Enforcement**: Requirement for publication

is some type of time-stamped version of core elements (Mellor & Nosek, 2018). Preregistration can include capturing any element of a study's design and execution. Ideally, preregistration includes hypotheses or specific research questions as well as the data-analysis plan (Munafò et al., 2017). Additional details of a preregistered study can also include an a-priori power analysis, a description of control variables to be included and why, and how missing data and outliers will be handled. Importantly, study preregistration does not preclude deviations. In fact, preregistration captures them so that they can be reported transparently (Toth, Banks, Mellor, O'Boyle, Dickson, Davis, & Borns, 2019). Also, preregistrations are not typically discoverable via internet searches (depending on the platform) and, to ensure privacy, an embargo can be placed on the preregistration for a set amount of time (e.g., two years). Preregistered links can also be blinded for the purposes of peer review. As a recent development, work has begun to provide recommendations for preregistering preexisting data (Mertens & Krypotos, 2019).

Study preregistration is by no means a new practice (Nosek et al., 2015). Although it is rarely seen in management and related fields, it continues to grow in popularity, as evidenced by the now more than 8000 study preregistrations on the Open Science Framework (Toth et al., 2019). The Center for Open Science recently completed a preregistration challenge in which 1000 research teams preregistered a study. Teams that published their preregistered studies were later paid $1000. Preliminary evidence shows that studies that were preregistered were better planned, more transparently reported, and included more unsupported hypotheses than comparison studies that were not preregistered (Toth et al., 2019).

Study preregistration has four benefits. First, it can improve the explanation of theoretical and practical problems (Banks et al., 2019). For instance, if one hypothesizes an interaction effect based on theory, study preregistration encourages researchers to explain clearly the anticipated nature of that effect (i.e., specific direction of the interaction). Second, it can improve study design due to better planning. For instance, a researcher who hypothesizes an interaction effect may be prompted in the preregistration to conduct an a-priori power analysis to determine the number of participants needed to detect an effect in the population (O'Boyle, Banks, Carter, Walter, & Yuan, 2019). Third, study preregistration can also improve data analysis as a result of better planning (Mellor & Nosek, 2018). For example, researchers may supply analytic code needed to conduct an analysis. This helps prevent mistakes and oversights when planning data collection.

Fourth, study preregistration can improve transparency in the reporting and publishing of study findings (Toth et al., 2019). For instance, the percentage of studies claiming to have found support for interaction effects in management has increased over time, despite the fact that statistical power has remained the same (O'Boyle et al., 2019). This may be due to a variety of factors, such as *p*-hacking and the selective reporting of results. More than likely, it is also a function of underpowered studies that lead to researchers capitalizing on chance, which increases the risk of false positives. If more interaction effects were preregistered, a greater number of studies would likely be designed with higher statistical power and the use of these QRPs may be reduced. As a second illustration, study preregistration helps distinguish between confirmatory and exploratory analyses (Wagenmakers, Wetzels, Borsboom, van der Maas, & Kievit, 2012). Both exploratory and confirmatory approaches have merit and help advance theory (Murphy & Aguinis, 2019). However, they have different functions, so presenting post-hoc findings as those developed a-priori can be quite harmful (for a detailed review see Wagenmakers et al., 2012). For instance, when engaging in question trolling (e.g., searching through a dataset in order to identify a significant relationship to report) one may uncover findings due to chance that will not replicate (Murphy & Aguinis, 2019).

The primary decision makers who need to take action to implement this recommendation are editors and funding agencies, although authors obviously play a role. Editors and funding agencies need to signal the importance of preregistration and to require it via revised policies. Authors will then need to engage in it. As of the writing of our article, most editors of management journals have remained silent on study preregistration and there are no journal policies requiring or even encouraging it (Banks, O'Boyle et al., 2016); nor are there published editorials that discuss it. There is a cost to not taking action in terms of reputation. Journals that do not encourage study preregistration risk publishing a greater number of false positives and studies that might fail to replicate. Also, it is worth noting that most funding agencies for social science research do not promote preregistration actively, although there are exceptions, such as the Defense Advanced Research Projects Agency (DARPA). Many authors are unaware of study preregistration as a process and evidence indicates that many hold misconceptions about what it actually is (Kavanagh & Kapitány, 2019; Toth et al., 2019).

Fortunately, much of the infrastructure needed to implement preregistered studies already exists, which lowers the barrier for implementing it. There are various frameworks, such as clinicaltrials.gov, Research Registry, Registry for International Development Impact Evaluations (RIDIE), Evidence in Governance and Politics (EGAP), Registry of Efficacy and Effectiveness Studies, the American Economics Association RCT Registry, and perhaps most notably for management, the Open Science Framework, developed by the non-profit Center for Open Science. There are no financial implications for creating study preregistration because the infrastructure is already in place. It is not clear exactly how much time it takes to preregister a study, as current estimates vary considerably based on each author's experience (Toth et al., 2019). We estimate that an experienced researcher who has completed multiple preregistrations will likely need 30–60 min to complete a new one. This estimate is conservative to account for the time a researcher might need to think through answers. That is, a typical preregistration form encourages researchers to consider questions that they may not have considered previously. For instance, if the typical study in management does not include an a-priori power analysis, the act of preregistration will prompt researchers to do that (Toth et al., 2019).

Finally, in terms of enforcement, editors could make preregistration of primary studies a requirement for publication. Studies that are not preregistered would be desk-rejected. Moreover, automation of the preregistration process could reduce any labor needed to screen studies (Johnson, Bauer, & Niederman, in press). Such a policy change would have to be announced well in advance to give researchers the opportunity to preregister new studies for their next round of submissions (e.g., 3 years in advance). Editors could allow authors to appeal this policy. For instance, if someone is submitting a study that is strictly exploratory in nature and draws upon archival data, the value-added contribution of preregistration may be reduced. Also, funding agencies can make funding contingent upon a commitment to preregister. If agencies such as the Department of Defense (DoD) and the National Science Foundation (NSF) require preregistration, authors would need to comply to secure project funding. Preregistration is already a requirement to secure funding from the DARPA Systematizing Confidence in Open Research Evidence (SCORE) program, which operates under the DoD.

3.3. Recommendation #2: Introduce a review track using a registered-report format

Registered reports are a popular format in many scientific domains (Chambers, Dienes, McIntosh, Rotshtein, & Willmes, 2015). They involve an author submitting a proposal to a journal that includes the typical introduction and methods sections, similar to how doctoral students propose dissertations (Grand, Rogelberg, Banks, Landis, & Tonidandel, 2018). Both study preregistration and a registered-report process involve capturing and communicating details related to a study plan. However, a registered report goes a step further because the research plan is actually peer-reviewed as a partial manuscript.

For registered reports, reviewers evaluate the merits of the theoretical and practical contribution as well as the methodological rigor of manuscripts. The proposal is then either rejected or offered a revise-and-resubmit invitation (R&R). If offered an R&R, an author may be asked to explain the contribution more clearly or to make critical adjustments. As a third possible outcome of the registered-report-review process, a proposal may be given an in-principle acceptance. This means that if the author executes the study as proposed, the manuscript will be accepted for publication regardless of the nature of the empirical results (Chambers, Feredoes, Muthukumaraswamy, & Etchells, 2014). Again, this is similar to how doctoral students are allowed to pass their dissertation defenses as long as they complete the research plan they proposed (Grand et al., 2018). The in-principle acceptance can still be withdrawn if the author deviates from what was originally proposed.

There are several benefits to the registered-report process (Sorokowski, Groyecka, Błaszczyński, Frąckowiak, & Kobylarek, 2019). Importantly, registered reports improve the credibility of findings (Chambers et al., 2015) and the reputations of journals and authors. A registered-report process allows for more truthful findings to emerge in the literature (Sorokowski et al., 2019) through two mechanisms (Grand et al., 2018). First, authors receive feedback on theoretical and practical contributions early in the knowledge-production process. The main reasons manuscripts are rejected from journals is that there are few theoretical and practical contributions or there are methodological flaws (Aguinis & Vandenberg, 2014; Antonakis, 2017). So, by receiving reviewer feedback early in the process, authors can save time, money, and energy not conducting a study likely doomed to failure. This lowers the typical amount of risk an author takes on when conducting a study.

Second, evaluation of the outcomes of a study is separated from the proposed contribution and its methodology (Grand et al., 2018). Authors and reviewers are subject to the same biases as any other humans (e.g., confirmation bias; Antonakis, 2017). For instance, in an experiment, reviewers were more likely to recommend publication of a study that had statistically significant results than the exact same study with null results (Emerson et al., 2010). In management, authors have reported that they have been asked to engage in QRPs by reviewers (Bedeian et al., 2010). By separating out reviewer evaluations through the registered-report process, such cognitive biases can be reduced. It is not clear if the rigid adherence to *p*-value cutoffs (Aguinis et al., 2010; Aguinis, Vassar, & Wayant, in press-b), α value cutoffs (Heggestad et al., 2019), or cutoffs of fit indices (Williams et al., 2020) is driven by authors who want to anticipate reviewer concerns or reviewers who are not letting papers "through the gate." That is, authors and reviewers may be using $p < .05$ as a proxy for "substantial contribution" and "methodological rigor" (Emerson et al., 2010).

The primary decision-makers to implement this second recommendation are editors. We encourage editors to use a special-issue format first, as this lowers the risk of trying out the initiative. A subsequent step would be to implement a second, permanent registered-reports track. Some journals in management have already done this in addition to the traditional full-manuscript peer-review track (e.g., *Journal of Business and Psychology*, *Journal of Organizational Behavior*, *The Leadership Quarterly*). However, a special issue is an easy way to try out the new process and allow journal editors to evaluate the approach more thoroughly. Financial resources involve standard production costs; beyond that, a special issue would involve a similar amount of work as any other special issue for action editors and reviewers. Interestingly, journals already doing annual-review editions have the infrastructure in place, as typical editorial practices for these editions require proposals as a stage-1 submission. Journals can then implement the registered-report-review track as an alternative option for new journal submissions.

3.4. Recommendation #3: Introduce a second submission track for results-blind reviews

The submission process in all journals in management and related fields involves authors submitting full manuscripts. While there are

Table 2
Recommendations for narrowing the science-practice gap in open science: Updating knowledge-transfer and knowledge-sharing processes.

Recommendation	Benefits	Primary decision-makers involved in implementing the recommendations	Resources needed to implement and enforce the recommendations
5. Provide an online archive for each journal article where authors can voluntarily place any study materials they wish to share	**Reporting and publishing** • Acceleration of knowledge sharing through the open dissemination of materials • Increased citations to articles and improved journal-impact factors **Study design** • Facilitation of replications	Editors	• **Financial resources**: None • **Time:** 3 months to collaborate with the Center for Open Science staff • **Additional resources**: Author guidelines • **Enforcement**: None
6. Implement mandatory data and analytic code sharing at initial manuscript submission (with the option to appeal to opt out)	**Data analyses** • Improved analytic reproducibility • Reduction in honest analytic mistakes • Reduction in data fabrication **Study design** • Improved dissemination of primary study data for meta-analyses	Editors	• **Financial resources**: None • **Time:** 3 months to collaborate with the Center for Open Science staff • **Additional resources**: Revised author guidelines, action-editor training to consider appeals • **Enforcement**: Desk rejection of noncompliant submissions, funding agencies can make funding contingent upon commitment to share data and code

advantages to this approach because it involves a holistic evaluation of a scientific project, there are also problems. For instance, reviewers' evaluations can be prone to confirmation bias, narrative fallacy, and hindsight bias (Antonakis, 2017). As previously mentioned, Emerson et al. (2010) demonstrated that reviewers evaluated manuscripts more favorably when results were statistically significant. Moreover, reviewers were more likely to find methodological flaws artificially planted in manuscripts when the results were not statistically significant.

The primary benefits of this third recommendation relate to reporting and publishing (Woznyj, Grenier, Ross, Banks, & Rogelberg, 2018). With results-blind reviews there is a possibility for improved reviewer evaluations that distinguish between theoretical and practical contributions as well as methodological rigor (Grand et al., 2018; Woznyj et al., 2018). In a results-blind evaluation process, reviewers provide comments on the introduction and methods sections of papers. In this way, action editors obtain evaluations of contributions and methodology independent of reviewers seeing the empirical results. Reviewers may then immediately gain access to the Results and Discussion sections. Alternatively, the initial review may be returned to authors for revision before moving on to the next stage (or it may be rejected). This process also reduces author incentives to engage in QRPs.

Primary decision-makers involved in implementing the recommendation are editors and publishers. The resources needed to implement the recommendation are quite basic. They include financial resources to create the software infrastructure for this second review track, as well as a few months to develop and pilot-test the track. Again, the type of infrastructure needed is nearly identical to that which is needed for annual-review editions that require authors to submit proposals in advance. Lastly, some training materials could be developed for action editors and reviewers. Authors would also need some guidelines in terms of expectations for the submission and the process.

3.5. Recommendation #4: Motivate authors to discuss validity threats honestly and precisely to re-invigorate the discussion sections of papers

Discussion sections of most published articles only superficially cover methodological and statistical limitations (Aguinis et al., 2010) as well as practical contributions (Bartunek & Rynes, 2010). The primary benefit of this recommendation pertains to reporting and publishing findings. Essentially there would be improved credibility and practical usefulness of scientific findings. Authors would be required to provide more detail regarding what inferences are reasonable from the findings and where readers should exercise caution.

Specialized methodological and statistical reviews by experts may be one means to promote this (Hardwicke et al., 2019). Some journals in management (e.g., *Journal of Management*) already employ such reviews for manuscripts that reach an advanced stage in the review process. Primary decision-makers involved in implementing the recommendation would be action editors to encourage authors to do this. Obviously, authors would also need to be involved in actual implementation. Few resources are needed to implement this fourth recommendation, as it would involve no financial resources, limited time, and limited revision in terms of guidance to action editors and authors.

4. Updating knowledge-transfer and knowledge-sharing processes

Our second broad set of recommendations focuses on how to update knowledge-transfer and knowledge-sharing processes (Shapiro et al., 2007). This can be an effective means to bridge the science-practice gap in the context of open science (Nosek & Bar-Anan, 2012). Table 2 summarizes these recommendations, together with the benefits, primary decision-makers involved, and resources needed for implementation to overcome any existing barriers.

4.1. Recommendation #5: Provide an online archive for each journal article where authors could voluntarily place any study materials they wish to share

This is a convenient way to promote open science by providing additional infrastructure to authors. The primary benefits pertain to reporting and publishing as well as study design. By providing open materials, we can accelerate knowledge sharing (Nosek et al., 2015). This can also increase citation counts to articles and, subsequently, journal-impact factors—a metric to which many publishers and editors pay close attention (Aguinis et al., 2020; Aguinis, Shapiro, Antonacopoulou, & Cummings, 2014). In fact, Christensen, Dafoe, Miguel, Moore, and Rose (2019) examined economics and political sciences journals and reported that articles that make their data available receive 97 additional citations. Consequently, there are immediate

Table 3
Recommendations for narrowing the science-practice gap in open science: Changing the incentive structure, improving access to training resources, and promoting shared values.

Recommendation	Benefits	Primary decision-makers involved in implementing the recommendations	Resources needed to implement and enforce the recommendations
Changing the incentive structure			
7. Introduce a best-paper award and acknowledgment based on open-science criteria	**Reporting and publishing** ● Positive recognition for open-science efforts	Editors	● **Financial resources:** None ● **Time:** 1 month from an ad-hoc committee of action editors ● **Additional resources**: Offer guidelines to the awards committee ● **Enforcement**: None
8. Encourage funding agencies to require open science practices (e.g., publicly posting all funded grants, supporting open-access publishing, preregistration, and data availability)	**Study design** ● Facilitation of replications and extensions of past studies **Data analyses** ● Improved analytic reproducibility ● Reduction in honest analytic mistakes	Funding agencies	● **Financial resources:** None ● **Time:** None ● **Additional resources**: Revisions to grant-submission guidelines ● **Enforcement**: Mandatory for those who receive funding
Improving access to training resources			
9. Provide access to open-science training	**Reporting and publishing** ● Improved quality of reviews ● Reduction of questionable research practices during the review process	Editors and reviewers	● **Financial resources**: None ● **Time:** None ● **Additional resources**: None ● **Enforcement**: Monitoring of training to designate a reviewer as "open-science evaluator"
Promoting shared values			
10. Publish editorial statements that null results, outliers, "messy" findings, and exploratory analyses can advance scientific knowledge if a study's methodology is rigorous	**Reporting and publishing** ● Reduction in authors' incentives to engage in questionable research practices ● Reduction in potential reviewer bias against "messy" findings ● Promotion of more holistic evaluations of results	Editors	● **Financial resources**: None ● **Time:** Editor's time to write editorials ● **Additional resources**: Action-editor training ● **Enforcement**: None

individual benefits to authors and journals, as well as benefits to the broader scientific community. Regarding benefits pertaining to study design, providing more open materials facilitates replications and expansion of the extant literature (Köhler & Cortina, in press).

Editors are the stakeholders primarily involved with implementing this recommendation. The financial resources needed to implement it are minimal to none. Journals can partner with organizations like the Center for Open Science, which has already developed the Open Science Framework. Journals can also develop website spaces themselves—and many do so already. There can be some additional basic author guidelines developed to explain what types of content can be posted.

4.2. Recommendation #6: Implement data and analytic code-sharing at initial manuscript submission (with the option to opt out)

Data are being lost at an alarming rate due to inconsistent practices in data storage and management (Wicherts & Bakker, 2012; Wicherts, Bakker, & Molenaar, 2011). Fortunately, we now have the technology to store data easily in the cloud rather than on personal computers. Moreover, we can make access to these data open so as to allow access to researchers for generations to come. Many authors have identified the need to share data across the social sciences and management scholars have conducted evaluations of various subfields (Bergh, Sharp, Aguinis, & Li, 2017; Hardwicke et al., 2018). While there are some differences in conclusions regarding analytic reproducibility, a clear conclusion is that open data and open analytic code would allow for significantly improved reproducibility (Hesse, 2018) and also facilitate the automation of certain scientific processes (Johnson et al., in press).

The primary benefit is that there would be improved data analysis. Providing open data and analytic code would allow for the reproducibility of our most important scientific breakthroughs (Hardwicke et al., 2018). While this approach can reduce honest mistakes, it can also reduce intentional data fabrication. From a study-design perspective, providing data would allow for improved meta-analytic reviews, and in general, the cumulation of scientific evidence (Hesse, 2018). This includes, for instance, item-level evaluation of scales, which is an improvement over current approaches (Carpenter, Rucker, & Schwarzer, 2011). Objections to posting data often include concerns such as confidentiality of research subjects, proprietary data, and fear of being preempted by other authors. However, there are solutions to these concerns (Alter & Gonzalez, 2018; Martone, Garcia-Castro, & VandenBos, 2018). For instance, participants can be notified in consent forms that anonymized data may be shared with other researchers. Also, data can be made available after publication to minimize authors' concerns of being preempted.

Primary decision-makers involved in implementing this recommendation are editors, in terms of making it a requirement for authors. There are little-to-no financial resources need to develop website space. Again, collaboration with the Center for Open Science's Open Science Framework may make this recommendation quite easy and reduce any infrastructure barriers. Revised author guidelines are needed, however. Action editors would need some basic training in terms of their knowledge of what types of datasets to allow as exceptions. Examples include proprietary datasets or datasets in which the rights of human subjects may be violated (Alter & Gonzalez, 2018). In terms of enforcement, manuscripts that are noncompliant may be desk-rejected and automation can be used to check all submissions (Johnson et al., in press).

5. Changing the incentive structure

This is a third approach for narrowing the general science-practice gap. Table 3 offers a summary of our recommendations and follows a similar structure as Tables 1 and 2.

5.1. Recommendation #7: Introduce a best-paper award and acknowledgment based on open-science criteria

Individual journals could identify specific criteria for the award. They might include categories such as study preregistration, open data, analytic code that facilitates reproducibility, or other research activities that seek to advance science by making innovative content open access. For instance, an award may be given to an author who develops a shiny app in R or machine learning code that is user-friendly and helps others reproduce, replicate, and extend a research domain by learning from methodological techniques or study materials. Some management journals (e.g., *Management and Organization Review*, *Strategic Management Journal*) already use another form of recognition. It involves providing badges for all articles that engage in open-science practices, such as preregistration and open data. Results have been positive in terms of incentivizing open-science practices (see Kidwell et al., 2016).

The main benefit of taking this approach pertains to reporting and publishing. That is, awards and acknowledgments are an effective way to promote positive recognition for open- science efforts (Nosek, Spies, & Motyl, 2012). The primary decision makers involved in implementing this recommendation are editors, who need to determine the criteria for the award and recognition. Editorial boards then need to form annual committees to evaluate published articles and to determine winners. While financial awards are quite powerful at signaling values, they are not a requirement. Virtually any kind of recognition will motivate authors to engage in such practices (Kidwell et al., 2016).

5.2. Recommendation #8: Encourage funding agencies to promote open-science practices

This recommendation directly aligns such practices with financial incentives. Funding agencies can publicly post all funded grants and support open-access publishing, as well as encourage preregistration and data availability.

Numerous benefits might result from this recommendation. These are the same benefits as those for study design. The open sharing of information allows for the facilitation of replications and extensions beyond previous studies (Köhler & Cortina, in press). Sharing data, analytic code, and other resources can also reduce honest mistakes and improve analytic reproducibility. If data and analytic code are shared, it makes it easy to reproduce analyses perfectly and likely reduces honest mistakes by researchers (Hardwicke et al., 2018).

The primary decision-makers involved in this recommendation are funding agencies because of the power of the purse. Agencies can easily maximize taxpayer and donor dollars by implementing such changes. Few resources are needed to implement them, either financial or time. The enforcement mechanism is that the changes are mandatory for those who receive funding. Hence, funding agencies can reward and incentivize those who develop and disseminate knowledge that benefits the broader scientific community.

6. Improving access to training resources

The fourth general type of approach for narrowing the science-practice gap involves improving access to training resources (Rynes, Brown, & Colbert, 2002). We offer a single recommendation directly related to this approach (see Table 3 for a summary).

6.1. Recommendation #9: Provide access to open-science training

Many resources exist that could be used. The cost of adding training resources to journal websites would be minimal. For instance, in partnership with the Consortium for the Advancement of Research Methods and Analysis (CARMA), the Society for Industrial and Organizational Psychology's (SIOP) Education and Training committee has begun reviewer training to promote reviewer development (Köhler et al., in press). This training is intended, in part, to educate reviewers about open science and to help reduce engagement in QRPs in the review process. CARMA has also partnered with ORM for advanced reviewer development. Articles to be published in a forthcoming special feature focus on matters such as transparency in how the data are collected and handled (e.g., missing data, outliers, control variables) prior to substantive analysis, as well as checklists for authors, reviewers, and editors (Aguinis, Hill, & Bailey, in press-a). Each of these articles is also accompanied by online video resources. Outside of management, organizations such as the Center for Open Science offer training on how to preregister studies and other related topics (see: https://cos.io/our-services/training-services).

The primary benefit of implementing this ninth recommendation is improved quality in peer reviews, combined with a reduction of engagement in QRPs during the review process. Education for reviewers should also help reduce reviewer bias (Köhler et al., in press). This step can also encourage reviewers to be more accepting of transparent, exploratory analyses (Murphy & Aguinis, 2019). Primary decision-makers involved in implementing this recommendation are editors and reviewers. As for enforcement, reviewers who complete specific training programs could receive badges and be qualified or even certified as "open-science evaluators."

7. Promoting shared values

The fifth approach to narrowing the general science-practice gap involves promoting shared values. Table 3 includes a summary of how we suggest implementing this recommendation to narrow the open-science research-practice gap.

7.1. Recommendation #10: Promoting shared values

There is evidence that researchers accept and support values related to open science (Anderson, Martinson, & De Vries, 2007). Emphasizing these shared values can be critical for narrowing the science-practice gap in open science. To do that, editors could publish editorial statements that null results, outliers, "messy" findings, and exploratory analyses can advance scientific knowledge if a study's methodology is rigorous (Hill, Bolton, & White, in press). There is a precedent for this type of combined effort in management, in which a group of editors collectively signal important values (https://editorethics.uncc.edu/editor-ethics-2–0-code/). The primary benefit of supporting shared values is to influence reporting and publishing, for example, by encouraging authors to reduce their engagement in QRPs, to reduce potential reviewer bias against "messy findings," and to promote more holistic evaluation of results.

The primary decision-makers involved in implementing this final recommendation are editors. The resource needed to implement this is the time of the editors to write editorials. We point to the editorial published by John Antonakis (2017) in *The Leadership Quarterly* as an exemplar. This editorial not only signaled the values of the journal, but discussed tangible changes to editorial practices. Since then, the journal has consistently improved its impact factor year after year relative to other journals in management and related disciplines. As a second example, *Journal of Business and Psychology*, which has been highly visible on the open-science front, has similarly experienced a noticeable increase in its impact factor. Clearly, these are just two illustrations and it is difficult to draw causal inferences. Yet these examples show that engaging in open-science practices does not necessarily mean that a journal's impact factor will decrease.

8. Concluding remarks

There is an urgency to address concerns about lack of reproducibility of scientific results. This is largely driven by concerns regarding engagement in QRPs, which are corrosive and challenge the credibility, trustworthiness, and usefulness of the scientific knowledge that is produced. Open-science practices can help reduce QRPs and accelerate the creation and dissemination of trustworthy scientific knowledge. Our article addresses the puzzling question of why, given the substantial amount of accumulated knowledge about open science and its benefits, management and other fields are not embracing the open-science movement. We argue that at least part of the answer is the existence of a *science-practice gap in open science*. There is a disconnect between the knowledge that is produced about open science issues and the use of that knowledge by practitioners of research, which include substantive researchers and gatekeepers in the science-production process (e.g., journal editors, funding-agency panel members, board members of professional organizations in charge of journal-submission policies). To narrow this gap, we offered 10 recommendations that are practical and actionable, and not just wishful thinking because they are explicit about the resulting benefits for the various stakeholders in research production. We hope our article will serve as a catalyst for future open-science initiatives and policies, which will also lead to the dissemination of more credible and trustworthy scientific knowledge.

9. Author note

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Credit authorship contribution statement

Herman Aguinis: Conceptualization, Writing - original draft, Writing - review & editing, Supervision, Project administration. **George Banks:** Conceptualization, Writing - original draft, Writing - review & editing. **Steven G. Rogelberg:** Conceptualization, Writing - review & editing. **Wayne F. Cascio:** Conceptualization, Writing - review & editing.

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