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ARTICLE

Incentivizing Transparency

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In 1942, Robert Merton famously laid out four norms of modern scientific practice[1]: universalism, communism, disinterestedness, and organized skepticism. The essence of these norms is that scientific truth is determined not by one's reputation or the desire to support a pet theory, but rather to defer to the evidence as judged by community-wide consensus. Though these norms are widely acknowledged within the scientific community, some researchers admit that they do not reach these ideals in practice, and most feel that their peers do not practice them.[2] In this environment, creating change is risky for any individual.

Despite believing in ideal scientific principles, researchers are rewarded not for idealism but for the number of publications authored, which requires novel and unexpected results.[3] This leads to a published literature that is widely skewed toward statistically significant results.[4] This suggests that the published literature does not accurately represent the totality of our knowledge.

The rewards for publishing positive, novel results represent a strong incentive to unintentionally present skewed evidence. Furthermore, there are many ways to skew evidence to make it appear more novel and exciting than it really is. For example, HARKing (hypothesizing after results are known) is the practice of presenting the results of a post hoc hypothesis test as if it were planned *a priori*.[5] Similarly, "p-hacking" is the process of reporting only a tiny subset of the actual total number of tests performed, often quickly and without meaning to distort the total body of evidence. Small and seemingly justifiable changes to an analysis can quickly shift a confirmatory hypothesis test into a more tenuous exploration of a dataset. This practice is widespread.[6]

John Ioannidis predicted that this clash between scientific ideals and practices would result in irreproducible results.[7] The Open Science Collaboration was only able to reproduce the results of less than half of the studies that they set out to replicate.[8] It is imperative that we improve the scientific ecosystem in order to reward ideal practices.

1 Merton RK. "The Normative Structure of Science." In *The Sociology of Science: Theoretical and Empirical Investigations*. Chicago, IL: The University of Chicago Press; 1973:267–278

2 Anderson MS, Martinson BC, De Vries R. Normative dissonance in science: results from a national survey of U.S. scientists. *J Empir Res Hum Res Ethics*. 2007;2(4):3–14. Crossref

3 Nosek BA, Spies JR, Motyl M. Scientific utopia: II. Restructuring incentives and practices to promote truth over publishability. *Perspect Psychol Sci*. 2012;7(6):615–631. Crossref

4 Fanelli D. "Positive" results increase down the hierarchy of the sciences. *PLoS ONE*. 2010;5(4):e10068. Crossref

5 Kerr NL. HARKing: Hypothesizing after the results are known. *Pers Soc Psychol Rev*. 1998;2(3):196–217. Crossref

6 Head ML, Holman L, Lanfear R, et al. The extent and consequences of p-hacking in science. *PLoS Biol*. 2015;13(3):e1002106. Crossref

7 Ioannidis JPA. Why Most Published Research Findings Are False. *PLoS Med*. 2005;2(8):e124. Crossref

8 Open Science Collaboration. Estimating the reproducibility of psychological science. *Science*. 2015;349(6251):4716–4716. Crossref

The Center for Open Science (COS) was founded in 2013 to increase the reproducibility of science. The key to increasing reproducibility is to increase transparency across the scientific workflow, as this allows for expert evaluation of each critical step in the process of gathering evidence. If every aspect of the research workflow can be reproduced and connected, then barriers to replicating previous work fall and the ability to critically evaluate work is strengthened. Achieving this vision will be challenging. Researchers face rewards that lead to the current situation, and those rewards must be addressed and changed. It will take the collective action of the entire academic ecosystem in order to reward better practices: publishers, universities, academic societies, and funding agencies.

Because of this challenge, COS undertakes three main activities. First, our meta-science team evaluates the extent of the problem and its proposed solutions. We conduct reproducibility projects in psychology[7] and cancer biology to estimate the ability to reproduce findings across a discipline. The work that we facilitate in the Many Lab projects replicate single studies across contexts in order to estimate the boundary conditions of any given finding. We also evaluate the effectiveness of our initiatives, for example, the effect of "Open Practice Badges" on increasing the rates of data and research materials sharing.[9]

Second, we educate and advocate for better practices through our community team. This not only includes conducting workshops, webinars, and creating materials on reproducible practices, but also creating policy guidelines and conducting education campaigns to encourage uptake. Our advocacy efforts seek to shift the incentives in the research ecosystem in order to reward rigorous and transparent practices over exciting, but irreproducible, findings.

A key example of our policy outreach is the Transparency and Openness Promotion (TOP) Guidelines. The TOP Guidelines provide eight modular standards that journals, publishers, or funding agencies can adopt in order to reward transparency over novelty. These standards cover practices such as data citation, data and materials sharing, design standards, preregistration, and replication.

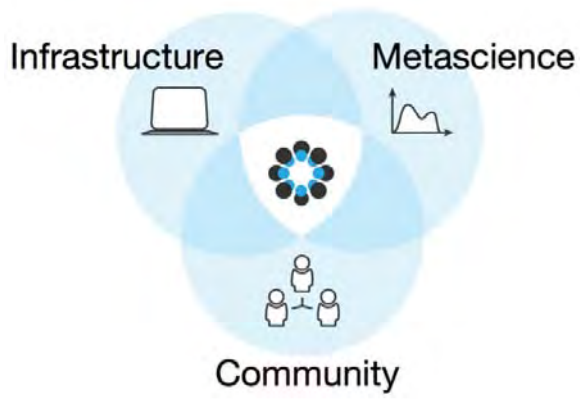

Figure 1. Our Metascience, Community, and Infrastructure teams work together to measure the extent of the problem, advocate and educate for change, and build the tools required to implement the solutions.

In order to reduce barriers to adopting the TOP Guidelines, each of the eight standards can be adopted at one of three levels of increasing rigor. The first level requires researchers to disclose a given action, the second requires the action, and the third level requires verification of that action. For example, the standard on data transparency can be adopted at the first level, which requires *disclosure* of whether or not data are publicly available. The second level *requires* data sharing (with editorial exceptions granted for ethical constraints). The third level includes *verification* that the data can be used to replicate the primary findings of a study. Not only does the tiered design reduce barriers to adoption, but it also provides guidance for future improvement. While few are ready to commit to the most stringent level, disclosure or sharing requirements can be readily implemented.

The Preregistration Challenge is a competition in which 1,000 researchers will receive $1,000 prizes for publishing the results of their preregistered work. This education campaign was designed to spur adoption of preregistration, in which key analytical decisions are specified before conducting a study. Preregistration makes clear the distinction

9 Kidwell MC, Lazarević LB, Baranski E, *et al.* Badges to acknowledge open practices: A simple, low-cost, effective method for increasing transparency. *PLoS Biol.* 2016;14(5):e1002456. Crossref

Figure 2. Preregistration makes clear the decisions made before seeing the data. Publish the results of a preregistered study and you could be 1 of 1,000 prize winners.

between hypothesis-testing (confirmatory) work and hypothesis-generating (exploratory) work. The distinction between the two processes can be surprisingly easy to blur as researchers dig through a dataset. Each decision made during an analysis is effectively a new hypothesis. For example, each decision about exclusion criteria, stopping rules, combining measured variables into outcome indices, and controlling variables has the opportunity to make a distinct analysis. Since a subset of those analyses will be statistically significant by chance alone, and since there is a such a strong incentive to find and publish that subset, many results can be presented as significant regardless of the overall evidence.[10]

One fear about preregistration is that it will tie a researcher's hands too much. Without the flexibility to discover unexpected findings, what might we miss? Obviously, science relies on serendipitous findings, and there is risk of missing an unexpected finding. Type II errors and false negatives can hinder our progress. But when confirming an expected finding, it is critical to preserve the utility of a *P*-value and to minimize false positives. Simply making clear when hypothesis-generating and hypothesis-testing work are being conducted increases transparency and the strength of assertions. Preregistration frees a researcher to explore a dataset to find those unexpected results

Figure 3. The Open Science Framework connects the entire research workflow. It solves problems common in most research labs: collaboration, turn-over, and persistence.

by removing the incentive to suggest the analyses are confirmatory.

Finally, the third focus of our work is to create infrastructure that enables the changes for which we advocate. The Open Science Framework (OSF) is our flagship product, a free and open-source workflow management tool that enables transparent and reproducible work. The OSF allows researchers to manage complex projects and to collaborate with peers. It has built-in features that encourage data sharing with unique, persistent identifiers. It can be used to register projects at different points in time. These registrations are read-only, persistent "snapshots" of a researcher's project. Projects can be registered at multiple points in the research lifecycle in order to preserve its state. Preregistrations are just one type of snapshot, which are taken before data collection begins. Other opportunities to make a registered snapshot include before submitting for peer review or around the time of publication.

The OSF can also serve as a hub for research being conducted at an institution. These institutional landing pages can help find collaborators and surface work being conducted more quickly and easily than through traditional outlets (see the University of Virginia's OSF page as an example).

Improving the reproducibility of published scientific literature is a complex challenge that can only be undertaken as a community. The COS

10 Simmons JP, Nelson LD, Simonsohn U. False-positive psychology: Undisclosed flexibility in data collection and analysis allows presenting anything as significant. *Psychol Sci*. 2011;22(11):1359–1366. Crossref

encourages change through our outreach and enables change with the tools that we build.

How can you get involved? Journal editors can promote these values by becoming signatories of the TOP Guidelines. Editors can also issue Open Practices Badges or conduct peer review before results are known using the Registered Report format. Researchers can take the Preregistration Challenge to clarify the distinction between analyses specified prior to seeing the data from those that arose later. Researchers can also use the OSF to manage their research, work with collaborators, or share data.

Our vision is a field in which all parts of the research workflow are transparent. This transparency improves rigor by allowing expert evaluation where it is needed. However, this vision will not be achieved without collective action, so please join us in helping improve the research ecosystem.

New ISMTE logo and brand story

The ISMTE unveiled a new logo, tagline, and brand redesign at the 2016 North American Conference. The updated look presents the Society as a unique community for managing and technical editors at scholarly publications worldwide that combines networking, training, and industry-proven best practices, allowing its members to engage with other professionals, broaden their day-to-day skills, and be proud of the journals they produce.

Look for the new ISMTE logo on future Society communications and more!