

## Better Science by Beating Back Bias

The human mind takes shortcuts by using past experiences to fill in missing information. This special talent helped our forebears avoid unfamiliar dangers and facilitated the development of modern civilization. Today, it allows us to quickly size up new social situations and connect with complete strangers. As researchers, it helps us see patterns in nature that explain how the world works. But this inherently human characteristic has its flaws. In its most benign manifestation, our reliance on shortcuts makes us susceptible to optical illusions or a magician's slight of hand. More troubling, our tendency to fill in missing facts by making broad generalizations can lead us to draw erroneous conclusions about our fellow researchers and the quality of their work.

The idea that our lazy minds and the ways that we are socialized can cause us to draw unjustified conclusions—a concept known as implicit bias—calls into question the integrity of the peer review process. After all, if one of the main pillars of modern science is affected by preconceived notions, how can we be sure that we are publishing the most reliable and important research? Upon learning about implicit bias in the peer review process, most of us assume that we are not the culprits. But just as we can be tricked by a skilled magician, all of us are susceptible to implicit bias in the peer review process. Implicit bias can creep into every stage of the review process, causing us to misjudge research abilities and quality due to assumptions associated with gender, country of origin, and the academic reputation (earned or presumed) of our authors and reviewers. Through our experiences as faculty members at institutions that take diversity seriously, our years as members of diverse research teams, and our personal commitments to diversity, we thought that we were truly objective when we serve as authors, peer reviewers, and editors. But a [simple exercise that forces you to confront your implicit biases](#) about students and peers, coupled with statistics about the review process in a journal in a closely related field, leads us to question this notion.

In 2017, [Lerbeck and Hanson](#) analyzed the gender of reviewers of the 20 peer-reviewed journals published by American Geophysical Union (AGU). They found that both men and women authors suggested fewer women reviewers than expected on the basis of AGU membership or prior authorship (i.e., 28% of AGU members and 27% of first authors are women compared to 21% and 15% of the reviewers suggested by women and men, respectively). AGU editors also invited fewer women to serve as peer reviewers than expected (22% and 17% of the invited reviewers by female and male editors, respectively, were women). In addition, even though AGU accepted authors (both female and male) reside in roughly equal parts North America, Europe, and Asia, AGU reviewers came primarily from the U.S., Canada, and Europe, suggesting geographic bias.

The existence of the AGU data set was fortuitous because the computer system that their journals used made it feasible to assess potential bias. Although we have not repeated this analysis for *Environmental Science & Technology* and *Environ-*

*mental Science & Technology Letters*, given the overlap between our communities, it is reasonable to assume that we also are not obtaining an appropriate gender balance and geographic representation in our reviewer pool. Moreover, our experiences as authors, reviewers, and editors leads us to surmise that authors tend to recommend established, senior researchers as reviewers—a group that is older and has a [disproportionate number of men relative to the overall author pool](#). Within this group, males from North American and Europe may be chosen more than those from Asia because authors are less familiar with the institutions and surnames of Asian senior authors.

What can we do to reduce this form of implicit bias in the peer review process? AGU responded to this issue by adding a statement to materials provided to authors during the manuscript submission process [encouraging authors to suggest a diverse set of reviewers](#). They also took steps to further diversify their editorial team and educate the community about the issue. Within three months of the inclusion of this statement, the gender diversity of suggested reviewers increased significantly and fewer women declined to review invitations. Although the submission statement improved gender diversity of reviewers, it had little effect on the country of origin of the recommended reviewers.

On the basis of AGU's success, we have added a similar statement to the instruction to authors and web submission forms for our journals. We also brought the issue to the attention of our Associate Editors who are responsible for selecting reviewers. We remain committed to recruiting Associate Editors and Editorial Advisory Board members that reflect the diversity of our authors. Over the next few years, we will track and report our progress in diversifying the reviewer pool by comparing reviewer selection before and after the introduction of the statement and publication of this editorial.

Although the use of a less diverse reviewer pool is problematic, implicit bias in the actual review process is more difficult to detect. Data from the AGU study suggest that, despite being underrepresented in the reviewer pool, manuscripts of women first authors were accepted at a slightly higher rate in AGU journals than those submitted by men. But this is not the complete story: using a standard that acceptance rates will be identical for different groups assumes that there are no differences in the standard of care for manuscript preparation or the quality of the research reported. For example, although we often return manuscripts to authors if the English does not meet our standards, a higher proportion of papers submitted by authors in Asia exhibit communication deficiencies. Likewise, the world's top universities attract outstanding researchers and support their efforts to a degree that likely results in more high quality submissions than those coming from less well-established institutions.

Implicit bias in the peer review process is a problem that will not be solved overnight (or with one editorial and a few changes to submission forms). By making the community

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aware of the phenomenon and identifying tangible measures that have already proven to work, we believe that we can make progress. If this is not effective, we need to consider approaches that are more disruptive to the existing peer review process (e.g., [double-blind review](#)). Ultimately, beating back bias to achieve better peer review outcomes is an important matter that will require a sustained, conscious effort from every member of the community.



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##### Notes

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