

NeuroView

(In)citing Action to Realize an Equitable Future

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Reference lists of neuroscience articles show marked gender imbalances. To mitigate this disparity, we discuss relevant ethical considerations and offer practical recommendations to scientists of all ages. We envision an equitable future by all scientists for all scientists.

The work of scholars and activists in the scientific community has pushed issues of gender and diversity to the forefront of the academy's consciousness in recent years. Discussions of "leaky pipelines" and "manels" are now prevalent, and many who were previously unaware of the scope of bias and injustice have been forced to reckon with the lived experiences of their peers. There may be a temptation to imagine one's own field as an exception, but recent work showing gender imbalances in neuroscience authorship, prizes, and speaking roles indicates otherwise (Schrouff et al., 2019). There then may be a temptation to point out that those decisions lie largely in the hands of the most powerful among us, like journal editors, society boards, department chairs, program officers, and conference organizers. Beyond ignoring the potential power of confronting such imbalances when they appear, the focus on the decisions of a few key people obscures the ways in which many imbalances are created and perpetuated by researchers at all levels. One important example is imbalance in papers' citation rates, the presence of which could have downstream effects on, for example, conference invitations, grant awards, promotion, inclusion in syllabi, and even student evaluations. Indeed, lower citation rates for women-led work have been observed in fields as varied as philosophy, political science, astronomy, and international rela-

tions (Caplar et al., 2017; Chakravartty et al., 2018; Dion et al., 2018; Maliniak et al., 2013; Thiem et al., 2018). In a recent paper (Dworkin et al., 2020), we find that this citation imbalance extends to neuroscience as well (Figure 1, left).

In this work, we investigated the gender makeup of reference lists from five top neuroscience journals (Dworkin et al., 2020): *Nature Neuroscience*, *Neuron*, *Brain*, *Journal of Neuroscience*, and *NeuroImage*. By examining reference lists, we were able to determine that not only are women-led papers cited less often than would be expected if gender was not a factor, but also that this effect is driven primarily by the reference lists of the papers that are first- and last-authored by men. This imbalance remains after accounting for various potentially relevant factors, including publication year, author seniority, journal of publication, article type, research subfield, and even authors' social network composition. The imbalance is also increasing over time as a result of stubbornly consistent citation behavior in the face of a diversifying field.

A reader may reply that they do not even know the gender of the authors they cite. This is very possible! However, if such a reader has taken classes with imbalanced syllabi, or attends conferences with imbalanced speaker lists, or seeks out articles in journals with imbalances in publication, they are likely to perpetuate these imbalances in their citation practices. Another reader may object

that there are remaining paper characteristics that could explain the imbalances. We stress that authors' focus on gendered paper characteristics may partially explain imbalanced citation practices, but it does not render that focus an ethical choice. In the following sections, we dive deeper into these issues. First, we lay out the ethical considerations and frameworks for citation behavior. Second, we discuss the ways in which scholars in a variety of scientific roles can best address the problem of citation imbalances. Finally, we describe the important research frontiers in this space and close with a call to action for members of our community to get involved personally and professionally.

Ethical Considerations and Frameworks

Citation behavior is the product of institutional structures and individual habits. Imbalances in citation behavior, therefore, are produced by both institutional biases and individual biases. By bias, we mean discriminatory (or, conversely, preferential) values, practices, or mechanisms, typically resulting in material, psychological, or physical harms. In the case of gender imbalances in historically male-dominated fields, institutional biases typically favor the status quo and thereby accrue more citations to a group of people with already disproportionately high citation counts. While sometimes blatant, institutional biases are often quite subtle.

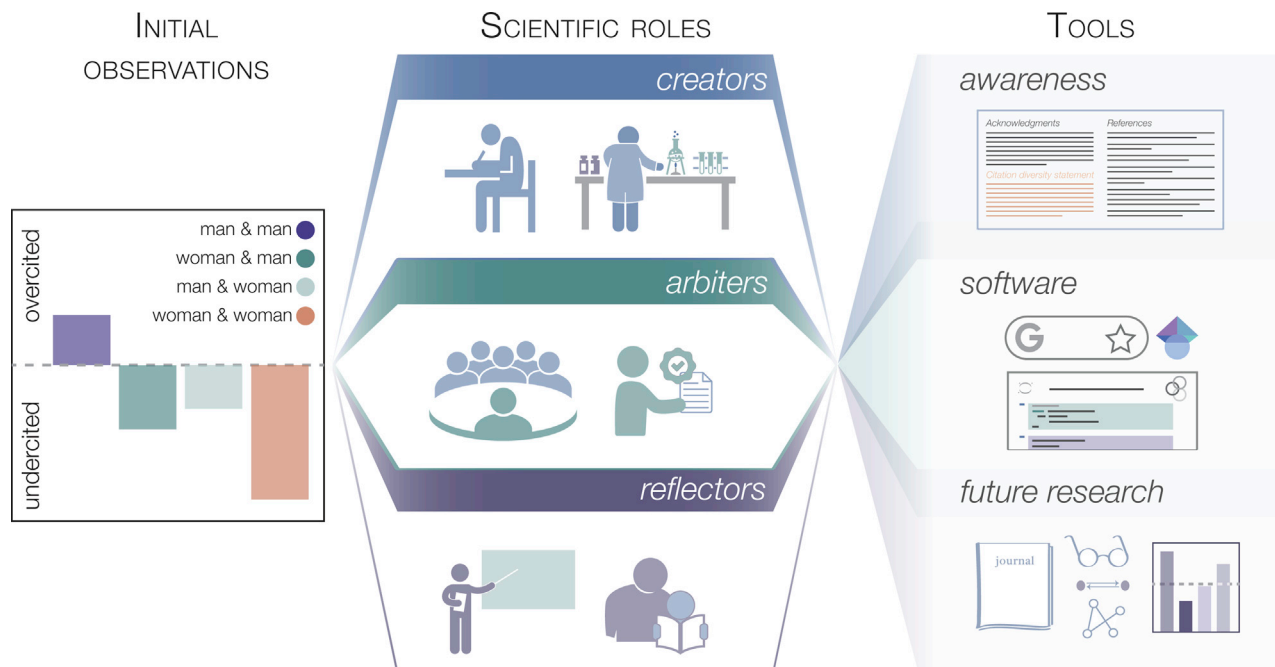


Figure 1. (In)citing Action to Realize an Equitable Future

(Left) Our initial observations reveal marked gender imbalances in the reference lists of papers published in high-tier neuroscience journals (Dworkin et al., 2020). (Middle) We provide a set of recommendations for how to address citation imbalances. Our suggestions are targeted to scholars in three canonical scientific roles: creators, arbiters, and reflectors. (Right) Tools to mitigate disparity can include: (1) a citation diversity statement to increase awareness, (2) publicly available and user-friendly software to estimate gender balance in a given paper's reference list (Zhou et al., 2020), as well as extensions for common search engines like Google Scholar to show predicted gender of authors on papers, and (3) future research across journal impact factors, throughout diverse fields, and extending from assessments of gender imbalance to assessments of racial imbalance.

If a field already lacks gender parity and if, furthermore, a field's citation practices are already imbalanced with respect to the field's existing gender diversity, it follows that if we replicate field-typical citation patterns and algorithmic search results for highly ranking papers, our citation practices will naturally remain imbalanced. One might protest that we have always written papers without evaluating gender balance in our reference lists, so why start now? Or this field has always been taught this way, with these texts, and these figures, so why change now? But these conservative movements to maintain the status quo may, in fact, exacerbate existing inequalities. These are just a few structural biases that support gender imbalance in citation practices.

But there are also individual biases in play—biases of which we may be fully aware or relatively unaware. Some scientists consciously believe, and expressly state (and reiterate), that men make for better scientists. This is an explicit bias. Many, if not most, scientists, however,

may implicitly favor men in their evaluation of scientific rigor or innovation, as expressed in their imbalanced conference invitations, grant evaluations, faculty hires, or student mentorship. Women are not alone in bearing the brunt of implicit bias. When bias supervenes on physical appearance, it may disadvantage women, people of color, people with disabilities, LGBTQ+ people, or even first-generation scholars that visibly lack financial, academic, and/or social capital. However, bias need not supervene on physical appearance. Much ink has been spilled to establish and quantify the widespread implicit bias relative to names, especially along the lines of gender and race. Our own analysis of citation patterns by gendered name tracks this thread. Assuming or insisting that one has no implicit biases is not only scientifically untenable, but also keeps one from investigating how one might conduct oneself as a scientist in ever more equitable ways. Noting that gender imbalance exists in reference lists, one might humbly turn to evaluate one's own citation pat-

terns and correct course if necessary. This response is indicative of a growth mindset.

There are two ethical models that might guide the development of an ethics of citation practice. The first, distributive model proposes that citations ought to be distributed equally, accurately reflecting the current diversity of the field. This model would require that neuroscience (and any other field interested in ethical citation practices) keep a regularly updated record of the gender distribution of its practitioners and then calculate the citation balance to reflect that distribution. Proponents would need to determine whether this record is to reflect faculty alone or also postdocs, graduate students, and undergraduate researchers. Regardless of that determination, the distributive model would be an improvement in the present situation, which is increasingly under-citing women's contributions over time. It would not, however, aid in the project of increasing the future gender diversity of the field, nor would it redress past harms and perceptions of

women and other underrepresented minority (URM) scholars as marginal to the field. The second, diversity model moves beyond the distributive model's attachment to economic parity and instead pursues epistemic justice. Without harming present science, it aims, through affirmative action and reparative justice, to correct for eons of scientific history and usher in a different future. Whether one chooses an ethics of equality and precision or one of equity and generosity, an ethics of citation practice ought to be a vital part of our work as scientists.

Recommendations

In this section, we provide specific recommendations to scientists in their various roles within the academy (Figure 1, middle). We first provide recommendations for those scientists who *create* new scientific content and drive its dissemination (e.g., the person(s) who is closest to the scientific process and who drafts or edits the subsequent manuscript). We then provide recommendations for those scientists who *arbitrate* whether that scientific content is publicized, either as a preprint (e.g., a principal investigator) or as a published article (e.g., journal editors and reviewers). Finally, we provide recommendations for those scientists who *reflect* the field to others (e.g., mentors, instructors, and review authors). We hope that each reader sees themselves in one or more of these roles in their current and future scientific careers. While we do not explicitly consider the role of institutional bodies in this work, we note that universities and grant funding agencies such as the National Institutes of Health and the National Science Foundation could require training in the ethics of citation practices as part of the responsible conduct of research (RCR).

Creators

Here, we consider the scientists who are the producers, generators, authors, designers, and originators of manuscripts, whether they be undergraduate students, research assistants, graduate students, postdocs, research staff, or principal investigators. These individual investigators have personal responsibility in both the state of *actuality* and the state of *potentiality*, and we will describe each in turn. First, in the state of actuality, you actually

have a manuscript drafted and you are nearly ready to submit. You have meticulously gone through every word, every turn of phrase, every sentence, every color combination in every figure, every argument in the introduction, every detail in the methods, every statistic in the results, every claim in the discussion, every line of code in your Github repository constructed in support of open science practices. You turn your attention last to your references, usually to ensure that they are formatted correctly. And now you remember to also (1) ask yourself whether your reference lists are gender balanced. How do you know? You have at least two options. First, use a common internet search engine such as Google to look up the authors on the papers you have cited and peruse their webpages, where you will learn more about their science in addition to learning their pronouns. Second, use open-source software to perform an automated probabilistic gender assignment based on the scientist's first name; the software will take in your reference list and offer back to you the predicted gender makeup of your cited first and last authors (Zhou et al., 2020; Figure 1, right).

If your reference list is not balanced, what do you do? You (2) educate yourself on the work of minority scientists that is relevant to your study. Your efforts are made easy by Women in Neuroscience (<http://winrepo.org>) and Anne's List (<http://anneslist.net>), two databases collating the names of women in neuroscience across many subdisciplines. You also (3) gather information about the current gender distribution of authors in your field. Your efforts are made easier by BiasWatchNeuro (<http://biaswatchneuro.com>) and an increasing number of discipline-specific studies of citation practices (Caplar et al., 2017; Chakravarty et al., 2018; Dion et al., 2018; Dworkin et al., 2020; Maliniak et al., 2013; Thiem et al., 2018). Then, you (4) determine whether you aim to reflect that current distribution or to proactively cite more work by minority scientists as an act of reparative justice and affirmative action in citational practices.

Now that your reference list is balanced, you (5) append a citation diversity statement to your paper to (i) hold yourself accountable, (ii) increase global

awareness of citation imbalance, and (iii) point future readers to relevant tools for mitigating disparity. Perhaps placed after the acknowledgments section, it might read something like this:

"Citation Diversity Statement. Recent work in neuroscience and other fields has identified a bias in citation practices such that papers from women and other minorities are under-cited relative to the number of such papers in the field (Caplar et al., 2017; Chakravarty et al., 2018; Dion et al., 2018; Dworkin et al., 2020; Maliniak et al., 2013; Thiem et al., 2018). Here, we sought to proactively consider choosing references that reflect the diversity of the field in thought, gender, race, geography, seniority, and other factors. We used automatic classification of gender based on the first names of the first and last authors (Dworkin et al., 2020; Zhou et al., 2020), with possible combinations including man/man, man/woman, woman/man, and woman/woman. Code for this classification is open source and available online (Zhou et al., 2020). We regret that our current methodology is limited to consideration of gender as a binary variable. Excluding self-citations to the first and last authors of our current paper, the references contain 12.5% man/man, 25% man/woman, 25% woman/man, 37.5% woman/woman, and 0% unknown categorization. We look forward to future work that could help us to better understand how to support equitable practices in science."

(Note: the percentages reported here reflect the reference list of this NeuroView.) ...And you submit!

Now, perhaps you were not in a state of actuality but instead in a state of potentiality: you are embarking on a new research project that could *potentially* become a paper. How do you choose your topic of study? If, as has been suggested by prior work, we tend to choose new research directions from highly cited papers, and papers written by men are cited more than papers written by women (Dworkin et al., 2020), then we tend to answer questions posed by men, and the trajectory of scientific discovery and

the crystallization of collective knowledge is biased away from the ideas produced by minority thinkers. In your previous paper, you may have come to the uncomfortable (or downright awkward) realization that you cited the work of women and other minorities in out-of-the-way places. But this time, you (6) proactively consider fleshing out ideas from women and other minorities early in the problem formulation stage, so that in fact women's work is central to your questions.

Arbiters

Here, we consider the scientists who are mediators, moderators, and adjudicators of the scientific publishing process, whether they be lab heads, journal editors, or reviewers. In a place of leadership as the gatekeeper standing between a manuscript and the public view, you (1) lead a team-wide discussion of literature on citation diversity; as a primary investigator (PI), that team is your group, and as a journal editor, that team is your editorial staff. Next, you (2) solicit a shared goal to reflect the current distribution of author gender or implement affirmative action in citational practices as a lab or journal policy. Next, you (3) do not open the gate until the paper has a reference list that the lab or journal would be proud of. Further, you (4) raise awareness by requiring a citation diversity statement. Journal editors could incorporate this requirement alongside their other checklists covering statistics, editorial policies, data sharing, and open science policies. You (5) spend time and resources assessing and reporting the proportion of papers in your field (as a lab head) or in your journal (as an editor) that are written by men (as first and/or last authors) and women (as first and/or last authors). At a journal, this effort serves both to inform potential authors of expected proportions and to hold the journal accountable to support the work of minority scientists. You (6) explicitly support the work of minority scientists by inviting them to co-author reviews (as a lab head) or author invited papers and commentaries (as a journal editor). You also (7) solicit URM reviewers of your preprint (as a lab head) or the manuscript submitted to your journal (as an editor) who may be better suited to evaluate the potential gaps in submissions' references. In fact, journal editors could ask reviewers to comment on the diversity of

the reference list in their review and to suggest relevant articles from minority scientists that the authors could consider citing in their revised manuscript. Even without a journal editor requiring this step, conscientious reviewers could take it upon themselves to offer such evaluations and recommendations as a matter of principle in their reviews of unpublished manuscripts.

Reflectors

Here, we consider the scientists who mirror, reflect, and canvas the scientific field for others, such as mentors, instructors, and review authors, of any age and any stature. This group of scientists could (1) commit to offering a balanced view of the field as it stands and an increasingly equitable view of the field as it grows. Epistemic injustice (Fricker, 2007) in the field is perpetuated when URM students, graduate students, postdocs, and junior faculty are made to believe that important work by URM scientists does not exist in a field (when it does), has not been influential in a field (when it has), or is valued as it should be (when it is not). While everyone in the field suffers from this injustice, the stereotype threat it promulgates serves to reduce young URM scholars' commitment to and resilience in the field. Efforts to diversify STEM fields necessitate making established URM scholars and their work more visible, accessible, and engaging, so as to facilitate a sense of belonging and worth among young URM scientists. Mentors could (2) facilitate summer research programs (e.g., the Big Ten's SROP initiative) and collaborative research between young and established URM scholars. Instructors could (3) check syllabi for underrepresentation and introduce students to relevant work by URM scientists in their areas of interest. Review authors could (4) expand their own and others' sense of the field by consciously including and, in some cases, highlighting work by URM scholars. For fields marked by existing, sustained, or even intensifying inequalities, change occurs by reflecting the field one wants to create.

Future Directions

Several important directions exist for future research (Figure 1, right). One direction is to build upon prior findings with new empirical studies of current citational practices in science. First, extend

prior work in a way that accommodates gender self-identifications of authors and that also accommodates intersex, transgender, and/or non-binary identities. Second, extend prior work by assessing the existence of imbalance along dimensions of race, ethnicity, class, sexuality, disability, citizenship, socioeconomic status, and university prestige. Third, extend prior work by assessing whether the extent and drivers of imbalance differ across subdisciplines of neuroscience or across high-, middle-, or low-impact factor journals. Collectively, such efforts would serve to address the limitations of previous studies and fundamentally broaden our understanding.

A second direction for future efforts would be to assess the efficacy of various interventions that are implemented as a result of this work. The first sort of study would assess whether an intervention works directly to alter the outcome of interest. Are the reference lists of papers that include a citation diversity statement more gender balanced? The second sort of study would assess whether an intervention targeting one outcome has subsequent effects on other outcomes. Are the reference lists of papers that cite a paper with a citation diversity statement also more likely to have balanced citations? Do papers that report an attempt to balance author gender also display greater balance in author race or ethnicity? If a journal editor provides a nudge (or requirement) to authors to balance their reference lists, do the same authors tend to balance their reference lists in future papers submitted to other journals? The third sort of study would assess whether early training in the ethics of diversity can drive an equitable future. Are students who take a class with a gender-balanced syllabus more likely to write papers with gender-balanced references? Do students working with a PI that requires balanced reference lists also tend to go on to lead labs that produce papers with balanced reference lists and that are filled with a diverse set of mentees?

Vision

When faced with what we *can* do, we might each ask ourselves, "What *will* I do?". For some, a utilitarian ethics might be enough: we ought to do our part to address injustices in science because

such actions are useful and are likely to benefit a majority. For others, a deontological ethics may prove more effective: we have a duty and responsibility to our current and future colleagues to address injustices in science. For still others, a virtue ethics is most compelling: we aspire to be humble, equitable, and generous scientists in our work as much as in our reference lists. Whatever the impetus, we wish for our friends in the academy to be fairly treated, and we wish for our students of all genders to have the opportunity to enter an academy that treats all persons equally. In our scientific culture without culturalism (Chelma and Keller, 2017), outrage can be healthy. Let us be outraged by the discrimination faced by gender-minority scientists (cisgender women certainly, but also non-binary and transgender people): our friends, partners, siblings, daughters, nieces, mentees, all with great hopes of a bright future. They deserve that future, and our actions today either bring that future closer or push it farther away.

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DECLARATION OF INTERESTS

D.S.B. currently serves on the Board of Scientific Counselors, National Institute of Mental Health.

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