

 BIBLIOMETRICS

Growing citation gender gap

Scientific work led by women tends to be cited less than comparable work by men, raising concerns that women's contributions to science are undervalued. Although numerous studies have looked at the statistics of citations received by papers, there are few measurements of the behaviours that drive the citation gender gap. Writing in *Nature Neuroscience*, Jordan Dworkin and colleagues present a case study of citation patterns in top neuroscience journals, finding that papers for which first and last authors are both men are over-represented in reference lists, and that the discrepancy is most prominent in the citation behaviours of men and is getting worse over time.

Dworkin et al. collected a pool of 61,000 papers in five high-ranking neuroscience journals from 1995 onwards. Using a combination of the US Social Security Administration baby name dataset and the gender disambiguation service Gender API, they assigned probabilistic gender labels to the first and last authors of papers and removed papers with authors whose gender could not be labelled, resulting in a dataset of 54,000 papers. They then examined papers in the dataset that were published in 2009–2018, looking

at which papers from the dataset they cited (excluding self-citations). The gender balance of these citations was compared with the gender balance of the dataset.

Even after correcting for the publication year, journal, number of authors, article type and author seniority of cited articles, papers with a woman as first and/or last author are cited less than expected, by as much as 13.9% for papers for which both first and last authors are women. The discrepancy is larger in the bibliographies of papers that have men as first and last authors — such papers under-cite papers with women as first and last authors by 23.4%. Furthermore, the gender gap in citations is increasing at a rate of 0.4 percentage points each year, indicating that even though the number of women in neuroscience is growing, citation practices do not reflect this change. “I was troubled by this marked increase over time,” says Danielle Bassett, corresponding author of the analysis.

A growing gender gap in citations has also been found by Junming Huang and co-workers, who studied the publication records of 3 million authors from 1900 to 2016 using data in Web of Science, with gender assigned to names using the software Genderize.io. Writing in *Proceeding of the National Academy of Sciences* earlier this year, they reported that the total number of citations received by women in the 1950s was in fact slightly higher than the number received by men, but the gap had reversed to 34% in favour of men by the 2000s — despite the proportion of women researchers increasing in

this time period. The gap in total citations was partially accounted for by men having longer careers on average, and after correcting for this factor the 34% gap was reduced to 12%, but was not eliminated.

Bibliographic databases have a lot to reveal about the behaviours of scientists, without relying on surveys that may not be comprehensive. There are limitations, though. Huang et al. restricted their dataset to authors outside of China, Japan, Korea, Brazil, Malaysia and Singapore, to avoid problems with reliability of gender disambiguation of names in Genderize.io. Dworkin et al. did not make any such restrictions, noting that Gender API supports names from 177 locations. However, being closed-source software, Gender API does not publish its data sources or algorithms.

Dworkin and colleagues plan to extend their work in two directions: assessing the existence of racial imbalances in reference lists, and studying fields other than neuroscience, such as physics. Doing so may require some adjustments to their analysis pipeline. As Bassett points out, “one challenge in porting the same analysis to physics is that there are some subfields in which the first and last author positions may not be as meaningful, such as in papers from particle physics collaborations.”

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ORIGINAL ARTICLE Dworkin, J. D. et al. The extent and drivers of gender imbalance in neuroscience reference lists. *Nat. Neurosci.* <https://doi.org/10.1038/s41593-020-0658-y> (2020)

RELATED ARTICLE Huang, J. et al. Historical comparison of gender inequality in scientific careers across countries and disciplines. *Proc. Natl. Acad. Sci. USA* **117**, 4609–4616 (2020)