Age, Gender, and International Author Networks in the Earth and Space Sciences: Implications for Addressing Implicit Bias

Brooks Hanson¹, Paige Wooden¹, and Jory Lerback²

¹American Geophysical Union, Washington, District of Columbia, ²University of Utah, Salt Lake City, Utah

Abstract

Author networks play a key role in doing science. Developing networks is critical for career advancement in a variety of ways, and differences in networks may be a core reason for persistence of implicit bias, particularly with regards to gender. Combining the American Geophysical Union (AGU) Fall Meeting abstracts from 2014–2018 with self-identified AGU member data on birth year and gender provides a large database of more than 400,000 unique coauthor interactions that we use to examine author networks by age, gender, and country. Age data are necessary to disambiguze the effect of a historic lack of women in the Earth and Space Science. The data show that women's networks are closer to those expected from the age–gender distribution of the overall membership; whereas, networks of men include more men than expected. Women also have more male coauthors within their age cohort than expected from the membership distribution. Women's networks are also less international than their male colleagues in most age cohorts. These differences start in the youngest age cohort. These data indicate that addressing implicit bias requires efforts at purposefully encouraging and developing more balanced author networks, particularly in early-career scientists. Recent work suggests that this will also improve science outputs.

Plain Language Summary

Today, most research is conducted in teams, which allows different techniques and expertise to be applied to a scientific investigation. It also allows for sharing skills among team members, which especially benefits students. The size of these research teams, which translates to co-authorship of conference presentations and manuscripts, has been growing and increasingly involves members from multiple countries. Professional connections made through teams are also import for career advancement. In this paper, we examine the age, gender, and extent of international collaborations of scientists by looking at authors of meeting presentations of one of the largest scientific meetings in the world, AGU’s annual Fall Meeting. We found that male scientists tended to have a higher proportion of male co-authors than would be expected at random and more international collaborations than women. These differences were apparent across most age groups, notably including authors in their twenties. This implies that actions are needed to help students of both genders equitably develop and expand their networks.

1. Introduction

Science is increasingly collaborative, and the best and most impactful science is regularly done in teams (Hall et al., 2018, provided a recent review; Wu et al., 2019). As such, individual success and career advancement increasingly depend on developing and fostering a broad network of collaborators. Large collaborator networks have myriad additional benefits, including recommendations for students and postdocs, help with research, and providing international introductions (e.g., Abramo et al., 2019; de Kleijn et al., 2020; Teplitskiy et al., 2018).

At the same time, implicit bias is increasingly being recognized in the practice of science—mostly around gender (often inferred from binary sex data) as that is the easiest to garner sufficient data for significance—but likely extending to age, ethnicity, and other forms of identities. This bias is manifested in lower invitations to serve as reviewers, acceptance rate in some disciplines (but not all), invitations to speak at conferences, hiring and promotion, award nominations, and many more activities (Ford et al., 2018; Fox & Paine, 2019; Ginther et al., 2011; Helmer et al., 2017; Holmes, 2015; Lerback & Hanson, 2017; Roper, 2019; West et al., 2013).

Several studies have shown that including women in key roles, such as editors or session conveners, reduces gender bias (Helmer et al., 2017; Lerback & Hanson, 2017). Reminders of bias and training also help, but
these measures do not always fully correct the observed differences, and recent studies have shown that biases persist despite these efforts. For example, several recent studies have still shown significantly fewer (ca. 5%) nominations of women by men for roles—for example, for reviewers by a male editor or speakers by a male session convener (Ford et al., 2019; Hanson & Lerback, 2017) even after some interventions.

One reason that addressing bias may be difficult and training alone is not sufficient is that the bias may be explicitly manifested in the networks that scientists form starting early in their careers, which creates a structural, persistent, and long-lasting effect. If, for example, suggestions and recommendations for reviewers or speakers and especially award nominations, often start from close networks, or follow along them, then bias would reflect differences in the makeup of networks among different demographic groups. If so, addressing the bias would require fostering diverse networks especially early in careers when close and lifelong collaborations form and continuing to do so over that career, a significantly more difficult and complex challenge than providing implicit bias training (which is still important).

To examine whether and how networks of men and women were different and thus might be contributing to persistent gender bias favoring men, we analyzed coauthors by gender and age using a large database of abstracts for the American Geophysical Union (AGU) Fall Meeting for the past 5 years (2014–2018). These datasets, merged with the AGU member database, provide self-identified information on age, gender, and country of residence of authors. In general, such information, particularly around age, has not been available in most prior studies, many of which also use name–gender algorithms where the uncertainty or error rate may be close to the size of signals of bias. Age data are necessary to disambiguate the effect of historical underrepresentation of women and other demographic groups in the sciences. Such data also allow us to assess how coauthor networks might vary or develop over career stages or with time. We also examine the geographical composition of coauthor networks and how these vary by age and gender. While professional networks are certainly broader than coauthors alone, these are particularly strong and trusted connections that persist through careers and are often used for recommendations, career references, and more. Broader geographical connections can help science in other ways too, for example, through science diplomacy, capacity building, and improved data access.

2. Approach

The AGU Fall Meeting is one of the largest annual scientific conferences worldwide. Recent meetings have had close to or more than 25,000 abstracts representing ~100,000 distinct authors each year from ~130 countries. Membership in AGU is generally required to submit an abstract, and most members have self-declared their birth year and gender. Additional data for some nonmembers including abstract coauthors are included in the AGU databases. Random checks indicate that these data are highly accurate (Lerback & Hanson, 2017). From 2014 to 2018, a 5-year period, these provide a data set with 417,632 unique coauthor pairs with age, gender, and additional demographic information (or 835,264 bidirectional connections), representing 70,519 unique authors where we were able to match age and gender. The total number of author pairs on abstracts over this time period is 1,239,473, so we were able to match about 67% with age and gender. The AGU Fall Meeting includes some abstracts from high-school students and early undergraduates (<20 years old) as well as scientists who were greater than 90 years old; we excluded these from the analysis (both coauthor connections from them and with them) as these groups are too small for statistical power. In all cases, age was adjusted for the time of the first activity; thus, we assigned author connections that persisted over several or all years to their youngest respective ages in this dataset. We grouped ages by decades; thus, we counted researchers whose ages and author networks spanned two decadal cohorts over the 5-year dataset in the younger cohort. Although we focused on unique pairs over the 5 years of meeting abstracts, analysis of all pairs across all 5 years or pairs in individual years separately yielded similar results (with higher or lower sample sizes and significance) and indicates that considering the age of first interaction over this multiyear sample is representative.

Most AGU members and abstract authors were from the United States, Japan, and Europe; participation from China has been growing (from ~2000 abstract authors in 2014 to ~5000 in 2018). Thus, our analysis is strictly for AGU members or other participants in society activities who have provided age and gender data, and we have likely undercounted especially some international collaborations with or among non-AGU members, as abstract authors who are not members are less likely to be from the United
States, Japan, and Europe. As the historical participation of women has been lower in many countries outside of North America and Europe, we expect that the observed gender differences are thus minima. Here we focus on the unique author networks rather than team size, persistence, or other dynamics. A related paper examines the relation between these networks and acceptance rates and citations in AGU journals (Lerback et al., 2020).

Coauthor combinations increase approximately exponentially with group size; thus, larger teams have a disproportionate influence on the cumulative set of networks. As shown in Figure 1 (data are in Table 1; Hanson et al., 2019), women are slightly overrepresented in the smallest author groups but are also well represented in some of the largest author groups (which are scattered). Overall, the large number of smaller to midsize teams in AGU abstracts (up to about 10) still contribute the most coauthor combinations to the results, and the distributions for these are similar to the average gender distribution.

3. Results

3.1. Gender–Age Networks

We analyzed author networks by gender and decadal age cohorts. Figure 2 shows the cumulative author networks by age and gender for each age–gender cohort (Figure 2; data are in Table 2 in Hanson et al., 2019). The networks are broadly similar to each other and reflect the overall AGU membership population distribution with slight but important differences. The proportion of women in the AGU member population is close to that of the employed geoscientists in the United States (US Bureau of Labor Statistics, 2015). All age–gender cohorts show the most coauthors with midcareer (30–59 years old) scientists. These cohorts include some of the most active researchers involved in both mentoring and forming larger research teams, form a large group of AGU members, and represent many of scientists presenting at the Fall Meeting. Because of historical bias against women, there are relatively fewer older women in the Earth and Space Sciences, and thus fewer senior women coauthors of other authors of any age and gender. As expected, younger coauthors of authors in all age groups include more women. About 10,000 of the ca. 417,000 unique coauthor connections were between two researchers in their 20s (or about 2.4%), whereas about 40,000 of the unique connections were between researchers in their 40s, or about 10%.

Figure 1. Effect of number of groups by size on overall author combinations and gender ratio. x-axis is gender-matched team size $n$. Green bars give overall proportional contribution of individual author combinations, $z \left( \frac{n}{2} \right)$ where $z$ is the number of abstracts of matched size $n$, on the total set of author combinations. Gray bars give average difference, in percent, from final overall gender average. Large groups have more potential author combinations but are rare (highest group size occurred twice). This analysis is for all abstracts across the 2014–2018 dataset, not unique coauthors where the first interaction only is counted, but provides a representative view of the dataset.
Figure 2. Cumulative author networks (in percent of total population) by age and gender for each age–gender cohort. Horizontal hashes indicate the age–gender distribution of American Geophysical Union members over this time period.
Although the patterns are broadly similar, some differences in networks by age are evident that also help understand gender and international differences (discussed below). In particular, men and women across all age cohorts tend to have had more coauthors—both men and women—of their same age (the bars in Figure 2 show the overall distribution of the full database of members and other authors where we have gender and age information over this time period). This is particularly the case in the older cohorts (50s and higher). The youngest cohorts, both men and women, have proportionally fewer coauthor relations with the older cohorts, and vice versa, than expected based on the overall member population.

Although all networks for age–gender cohorts are broadly similar, the data show that women’s networks for any age cohort have relatively—typically several percent—more women as coauthors than their male counterparts (Figure 3) and that this difference persists across most age cohorts. This includes the early-formed networks between researchers in their 20s and 30s. Interestingly, the coauthor network for women in any

**Figure 3.** Percentage of women within each age cohort in the overall coauthor network of men and women of each age cohort. Horizontal hashes indicate the age-gender distribution of American Geophysical Union members over this time period. Error bars are ±95% standard confidence intervals.
age cohort is close to the overall AGU membership distribution; in contrast, for men, women are underrepresented by about 5% in each age cohort. This difference is highly significant for most networks (see Table 3 in Hanson et al., 2019), except those involving scientists in their 70s and 80s, where there are few women in particular. The difference is also close to that seen above in recommendations for reviewers and invited speakers by male and female leaders (Ford et al., 2018).

We can use the number of abstracts per author and average number of coauthors by age as a proxy for the development of networks by researchers over time (Figure 4 and Table 4 in Hanson et al., 2019). The data show that the number of abstracts essentially doubles by decade for authors between their 20's and 40's, as does the number of coauthors per person. This increase is similar for both men and women. Given the 5-year time window of our analysis, this would not reflect the full coauthor network over a career, which would be expected to be larger, but does give a sense of how active networks might develop. Overall, men were authors on 5.9 abstracts in the 5-year period whereas women were on 4.2 abstracts on average. This difference partly reflects that the average age of men as authors is older than the average age for women, but even within each cohort, men are authors on an average of 1.7 more abstracts over this time period (Figure 4).

### 3.2. International Teams

We analyzed authors’ international networks using the country in author addresses on their earliest abstract of our dataset. In this analysis, we considered the 15 top countries individually but grouped authors in other countries into regions (Africa, rest of Asia, Europe, and South America) as many countries had a single or few authors. Most (94%) of the relations were among authors in the top countries. The data below for authors in each age cohort are for their coauthors across all age groups including their own. Of the 149,125 distinct abstract authors, 95% had a known country (144,708). Of those, 47% were from the United States, 18% were from Europe, and 8% were from China. Of the distinct abstract authors with a known country, we were able to match 49% with age and gender. Women represented 33% of the distinct abstract authors overall and 36% of the authors from the United States, 34% from China, and 33% from the United Kingdom. Of the top 10 countries, Japan had the smallest proportion of female authors with 15%.

Not surprisingly, as the AGU Fall Meeting has always been held in the United States, many coauthor relations, 53%, are between US-based authors. But still a good number of US authors, including early-career researchers, have one or more international coauthors among all their connected authors.

Regardless of national affiliation countries, women had fewer international coauthors than men (Figure 5 and Table 5 in Hanson et al., 2019). This is observed both across all ages and within each age cohort. The differences for each cohort indicate that having a broader overall international network is not solely an age effect (where the older average age of male authors is associated with a larger and thus more international network). About 50% of women and 60% of men have at least one international coauthor (Figure 5, top). This pattern holds across major country-level data. In the United States, for example, just over 40% of women and 50% of men have at least one international coauthor. This is similar to that of China. In both the United States and China, the proportion of women in nearly all age cohorts with an international coauthor is less than comparably aged men, typically by 5 to 10%, and as these countries have the largest number of authors attending the AGU Fall Meeting, these dominate the overall pattern. Elsewhere, however, particularly in some countries in Europe but also Japan and Canada, a similar proportion of men and women have at least one international coauthor across age groups. In the EU especially, this may reflect dynamics of science collaborations, mobility, and education across member countries.

The youngest author cohort had fewer international author groups than any other age group. The proportion of 20–29 year-old men and women with international coauthors is still fairly high: 35% of US women and 40% of US men have at least one international collaborator; 40% and 45%, respectively, in China; and higher in Europe. Comparison with the authors where we were unable to match gender and/or age (which are generally not AGU members), but could still identify international collaborations, implies that AGU members are somewhat more connected internationally overall than nonmembers (46% of authors with unknown age and gender have an international connection, versus 56% of the matched authors). In data where we could match gender but not age, the same gender differences persist.
A complementary way to look at international networks is to consider the insularity of coauthors. For this analysis, we define insularity as the proportion of all coauthors in the aggregated network of authors from a country that are in the same country (Figure 5 and Table 5 in Hanson et al., 2019). For US authors, about 80% of their coauthors were also in the United States. This was the most “insular” network represented in our data and likely in part reflects the US location of the meeting, AGU’s membership, and the large size of the research community in the US. Japan-based authors were the second most insular with 72% of their overall network with other Japan-based authors. Authors in Switzerland (35%), the Netherlands (39%), and Spain (39%) had the least insular networks among major countries represented at the Fall Meeting. Collaborators from these countries were spread out among colleagues in the United States, the United Kingdom, and other countries in Europe. Non-US authors who network with US authors the most were from Canada (29% US) and Africa (24%). Italy- and Japan-based authors have the smallest relative US author network with 16% and 11%, respectively. China-based authors network mostly with authors in China (67%) and the United States (19%). They have relatively few connections with authors in their geographical region such as Japan (1% of their network) and other Asian countries collectively (2% of their network).

In general, younger authors’ networks, especially for those in their 20s, were more insular than those in later age cohorts (Figure 5). This is not surprising because their networks are still nascent and grow out from their departmental advisor and peers. Most networks decreased in insularity as the age cohort increased.
For most countries, including the United States and China, women’s networks were more insular than those of their male counterparts (16 of the 20 country-regions but not all are significantly different), and across most age cohorts, consistent with the analysis above. Of these country-regions, the largest differences were in Spain (women 41% insular, men 31%), Africa (women 45% insular, men 39%), and South America (women 57% insular, men 51%). However, there are a few countries where women’s networks were less or equally insular: namely Canada (women 44% insular; men 45%), Switzerland (women 31%; men 32%), and the United Kingdom (both 43%).

We separately looked for possible trends with respect to both international engagement and gender and age diversity of coauthors over the time period of the data, but many trends were not significant, and none were inconsistent with these results. International attendance increased to the meeting over the years from some countries, notably China.
4. Discussion

These coauthorship patterns have several implications. First, the data are consistent with the notion that at least some of the persistent differences in invitations by men versus women for awards, reviewing, and speaker roles (among others) are related to differences in their networks. Although there could be other confounding factors, strong familiarity with colleagues via coauthorship or other close connections is a logical explanation for some of the differences. It is interesting that the observed network differences of about 5% overall and within most age cohorts is of the same magnitude as the commonly observed differences in invitations. This would also then explain why training and awareness of bias alone have not fully mitigated implicit bias: It is more difficult to overcome a real structural difference. The comparison with the overall AGU distribution suggests that this is not simply homophily (Helmer et al., 2017; Murray et al., 2019)—where researchers of one gender tend to interact with or recommend each other. Women’s networks are balanced with respect to the AGU gender–age distribution compared with the overall expected population, whereas men’s networks in the Earth and Space Sciences are male-dominated.

As a test of the importance of networks in speaker roles, we looked at the participation of authors in sessions developed and convened by their coauthors in the AGU Fall Meetings over the same time period (Table 6 in Hanson et al., 2019). For this meeting, sessions are first proposed by 2–4 conveners, then most are open for general submission of abstracts. Usually, two abstracts can be formally invited but a few sessions have up to 10 invited abstracts. We considered all coauthors from the full dataset, not each meeting separately. From 2014 to 2018, 35% (41259/117802) of all the abstracts submitted to sessions were from one or more coauthors of the conveners for that session, and 14% (4910/31886) of the invited abstracts included a coauthor. One or more coauthors of conveners were on the majority of abstracts (>50%) in 33% of all the sessions and were an author on all of the abstracts in 2.5% of the sessions. We do not know how many of these authors that submitted but were not formally given “invited” roles were also contacted by the conveners to submit a regular abstract, were just notified of the session, or simply discovered and selected the session recognizing the conveners and topic, although many conveners do reach out to their contact networks. Regardless, the data show that coauthor network effects are significant drivers of participation in sessions. These data, and the differences shown here in the gender–age makeup of networks, likely help explain some of the biases seen by Ford et al. (2018, 2019) in speaker roles at the Fall Meeting.

Second, the data also imply that women may not have the same opportunities to build international collaborations as male counterparts, are not taking full advantage of opportunities, are not able to take advantage of these opportunities, are discouraged from these opportunities, or all of these (Frehill & Zippel, 2011; Abramo et al., 2013; Uhly et al., 2017; Zippel, 2017, 2018). Given the growing importance of international collaborations for addressing large challenges in the Earth and Space Sciences, and the importance of these connections for career advancement (Abramo et al., 2019; Hanson et al., 2017), these differences are also important to address.

Finally, differences in author networks, both with respect to gender and international diversity, are apparent among early-career scientists, and similar differences are apparent for older scientists. To the extent that early formed collaborations and networking habits persist through careers, the coauthor data suggest that the “old boys club” starts as a “young boys club.”

This result implies that addressing implicit bias should focus on intentionally and equitably extending collaborative opportunities to early career scientists with this understanding of demographic inequalities. Programs, practices, tools, and advice should be aimed at demographically balancing the networks of men and extending networks particularly of underrepresented groups (Zippel, 2017). Proactive efforts to promote engagement and collaborations across research groups and departments would be critical. If these network effects are socially and structurally ingrained and reinforced, as they likely are, corrective actions may take time to manifest throughout the scientific workforce.

A separate analysis comparing author groups and acceptance rates across AGU journals for the same time period (Lerback et al., 2020) shows that the acceptance rates and citations of papers with gender-diverse and internationally diverse author groups are higher than those for single-gender author teams and single-country author teams. This result in the Earth and Space Sciences, which supports results from other studies in other disciplines (Nielsen et al., 2017; reviewed in Hall et al., 2018), indicates that forming diverse
teams leads to better and more impactful science. For addressing implicit bias, it implies that there is a positive feedback for creating gender diverse and internationally diverse teams—it may lead to better science. Thus, there is or should be incentives for both of these efforts. Even small benefits accrue over the course of a career and in aggregate.

Finally, this analysis emphasizes the need to account for and include age data in such analyses and the value of data within scientific societies that can be connected with their meetings and publications. We encourage other societies to work to collect this data and amplify and extend this work.

**Data Availability Statement**

This analysis merges a public dataset on published AGU abstracts with member-provided data on year of birth, gender, and personal emails. Analysis and publication of aggregated member data are consistent with AGU’s privacy policy https://www.agu.org/Privacy-Policy. Although the abstract records are public and available here, https://abstractsearch.agu.org/about/, the matched member data are covered under this policy and cannot be released publicly. Given the information contained in and used for this analysis in the abstract data and other available information, it is not possible to fully anonymize the complete merged dataset to prevent release of any member data (even if not all of it) even if much of the data set could be assembled separately from public records. Summary tables in support of the analysis are provided in this manuscript and at this Zenodo archive (Hanson et al., 2019; DOI: 10.5281/zenodo.3591871).

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**References**

Abramo, G., D’Angelo, C. A., & Di Costa, P. (2019). The collaboration behavior of top scientists. *Scientometrics, 118*(1), 215–232. https://doi.org/10.1007/s11192-018-2970-9

Abramo, G., D’Angelo, C. A., & Murgia, G. (2013). Gender differences in research collaboration. *Journal of Informetrics, Elsevier*, vol. 7(4), 811–822. https://doi.org/10.1016/j.joi.2013.07.002

de Kleijn, M., Jayabalasingham, B., Falk-Krebsinski, H. J., Collins, T., Kuiper-Hoing, L., Cingolani, I., et al. (2020). “The Researcher Journey Through a Gender Lens: An Examination of Research Participation, Career Progression and Perceptions Across the Globe.” Retrieved from www.elsevier.com/gender-report

Ford, H. L., Brick, C., Azmitia, M., Blaufuss, K., & Dekens, P. (2019). Women from some under-represented minorities are given too few talks at world’s largest Earth-science conference. *Nature, 576*(7785), 32–35. https://doi.org/10.1038/d41586-019-03688-w

Ford, H. L., Brick, C., Blaufuss, K., & Dekens, P. S. (2018). Gender inequity in speaking opportunities at the American Geophysical Union Fall Meeting. *Nature Communications, 9*(1), 1138.

Fox, C. W., & Paine, C. E. T. (2019). Gender differences in peer review outcomes and manuscript impact at six journals of ecology and evolution. *Ecology and Evolution, 9*(6), 3599–3619. https://doi.org/10.1002/ece3.4993

Frehill, L. M., & Zippel, K. S. (2011). Gender and international collaborations of academic scientists and engineers: Findings from the survey of doctorate recipients, 2006. *Journal of the Washington Academy of Sciences, 97*(1), 49–69.

Göntner, D. K., Schaffer, W. T., Schnell, J., Masimore, B., Liu, F., Haak, L. L., & Kington, R. (2011). Race, ethnicity, and NIH research awards. *Science, 331*(6045), 1015–1019. https://doi.org/10.1126/science.1196783

Hall, K. L., Vogel, A. L., Huang, G. C., Serrano, K. J., Rice, E. L., Tsakraklides, S. P., & Fiore, S. M. (2018). The science of team science: A review of the empirical evidence and research gaps on collaboration in science. *American Psychologist, 73*(4), 532–548. https://doi.org/10.1037/amp0000319

Hanson, B., & Lerback, J. (2017). Diversifying the reviewer pool. *Eos, 98*. https://doi.org/10.1029/2017EO083837

Hanson, B., Lunn, J., Van der Pluijm, B., Orcutt, J., Colwell, R., Trumbore, S., et al. (2017). Earth and space science for the benefit of humanity. *Eos, 98*. https://doi.org/10.1029/2018EO071991

Hanson, B., Wooden, P., & Lerback, J. (2019). Datasets for age, gender, and international author networks in the Earth and space sciences: Implications for addressing implicit bias. *Zenodo. https://doi.org/10.5281/zenodo.3591871*

Helmer, M., Schottorf, M., Neef, A., & Battaglia, D. (2017). Gender bias in scholarly peer review. *eLife, 6*, e21718. https://doi.org/10.7554/eLife.21718.001

Holmes, M. A. (2015). Implicit assumption: What it is, how to reduce its impact. In M. A. Holmes, S. O’Connell, K. Dutt (Eds.), *Women in the Geosciences: Practical, Positive Practices Toward Parity*, special publications 70 (Chap. 9, pp. 81–93). Washington, DC: American Geophysical Union.

Lehrback, J., & Hanson, B. (2017). Journals invite too few women to referee. *Nature News, 541*(7638), 455.

Lehrback, J., Hanson, B., & Wooden, P. (2020). Association between author diversity and acceptance rates and citations in peer-reviewed earth science manuscripts. *Earth and Space Science, 7*, e2019EA000946. https://doi.org/10.1029/2019EA000946

Murray, D., Siler, K., Larivière, V., Chan, W. M., Collings, A. M., Raymond, J., & Sugimoto, C. R. (2019). Author-reviewer homophily in peer review. *BioRxiv, 400515*. https://doi.org/10.1101/400515

Nielsen, M. W., Allegri, S., Börjeson, L., Etzkowitz, H., Falk-Krebsinski, H. J., Joshi, A., et al. (2017). Opinion: Gender diversity leads to better science. *Proceedings of the National Academy of Sciences, 114*(8), 1740–1742. https://doi.org/10.1073/pnas.170661114

Roper, R. L. (2019). Does gender bias still affect women in science? *Microbiology and Molecular Biology Reviews, 83*(3), e00018–e00019. https://doi.org/10.1128/MMBR.00018-19

Teplitsky, M., Acuna, D., Elamrani-Raoult, A., Körding, K., & Evans, J. (2018). The sociology of scientific validity: How professional networks shape judgement in peer review. *Research Policy, 47*(9), 1825–1841.

Uhy, K. M., Visscher, L. M., & Zippel, K. S. (2017). Gendered patterns in international research collaborations in academia. *Studies in Higher Education, 42*(4), 760–782. https://doi.org/10.1080/03075079.2015.1072151
US Bureau of Labor Statistics (2015). Women in the Laborforce: A Databook Report 1059.
West, J. D., Jacquet, J., King, M. M., Correll, S. J., & Bergstrom, C. T. (2013). The role of gender in scholarly authorship. *PLOS One*, 8(7), e66212. https://doi.org/10.1371/journal.pone.0066212
Wu, L., Wang, D., & Evans, J. A. (2019). Large teams develop and small teams disrupt science and technology. *Nature*, 566(7744), 378–382. https://doi.org/10.1038/s41586-019-0941-9
Zippel, K. (2017). *Women in global science: Advancing academic careers through international collaboration*. Stanford, CA: Stanford Univ. Press.
Zippel, K. (2018). Gendered images of international research collaboration. *Gender, Work and Organization*, 26(12), 1794–1805. https://doi.org/10.1111/gwao.12233