Speaking of gender bias

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A lot can be learned about the history of science in America from browsing through the front matter of PNAS across its 104-year history. You'd have to look through 73 volumes, for example, before coming across the name of the first distaff editor-in-chief. In 1985, molecular biologist Maxine Singer became the journal's first female editor; at the time she was appointed, she presided over an Editorial Board of 16 NAS members, all of whom were men. By the time her term ended in 1988, plant molecular biologist Mary Dell-Chilton had joined the board, raising its percentage of female members from 0 to 6%. Today, PNAS has 215 Editorial Board members, 52, or 24%, of whom are female. All things considered, that's not really an impressive rate of change—just short of a fourfold increase in representation across three decades. Even the US Congress, a longtime bastion of masculinity, has managed to better that rate; over that same time interval, the representation of women in Congress increased from 25 to 110 (proportionately, from 2 to 20%). Election to Congress, however, is open to members of the US population who meet a half-dozen or so minimum requirements of age, citizenship, and residency, so for decades, the eligible pool has been ~50% female. In contrast, appointment to the PNAS Editorial Board is limited to members of NAS, another longtime bastion of masculinity, and election to NAS has many more stringent requirements than does election to Congress. In 2019, NAS has 2,811 members (including active members, emeritus members, and foreign associates); of these, 448 are women (16%). Although many factors may be invoked to account for the fact that, today, male emeritus members outnumber female emeritus members 10 to 1 (70 vs. 6), the ratio is in part a reflection of the historical gender skew of NAS membership.

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Gender Issues, Front (Matter) and Center

Browsing the front matter of PNAS made me wonder about the extent to which gender has been a topic of interest within the journal, particularly as it affects the scientific publication process. Service as an editor or editorial board member of a scientific journal isn't exactly a fast track to lasting fame; whereas a search with the phrase "legendary newspaper editor" yields 1,150 hits, a search with the phrase "legendary journal editor" yields only 100 hits across the entire Internet, and most of these don't even refer to science journals. Franz Ingelfinger, editor of the *New England Journal of Medicine* from 1967 to 1976, did earn eponymous fame establishing a policy whereby the journal would not publish research previously published elsewhere, now known as "the Ingelfinger Rule." Notwithstanding the limited opportunities for fame or fortune, editorial service is an essential component of the scientific enterprise. Irrespective of the discipline, editors and editorial boards of science journals have served as stewards of the scientific literature—establishing criteria for standardization and regularization of content; evaluating adherence to accepted practices within a discipline; developing systems for timely, objective, and thorough assessment through expert peer review; and preserving content through time. Because editorial service has the potential to influence the progress and direction of a scientific field, appointment to an editorial board reflects the high regard and trust of a community of colleagues. That said, not all editors or boards are equally successful at achieving these objectives. Notable failures can occur at every stage of the editorial process, and of late, there have been calls to dispense with journals altogether as outmoded "300-year-old scientific technologies" (1) and to transition to open-source postpublication peer review. Thus, the relevance clock may be ticking even for Ingelfinger, not to mention the rest of us.

Among the more conspicuous failures in scientific publishing has been its inability to break free from gender imbalances that permeate the editorial process, including leadership (2), peer review (3), and

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manuscript authorship (4). Such imbalances have been documented across the biological, physical, social, and medical sciences in a rapidly growing body of literature that is exceedingly challenging to review because the degree of imbalance and the nature of its apparent causes vary enormously not just across disciplines but even within disciplines [e.g., dental science (5)]. Today, a search of Web of Science yields more than 1,700 references with the phrases "gender bias" or "gender inequality" in the title. Many of these papers are discipline specific; as a multidisciplinary journal, however, PNAS is theoretically well positioned to publish scholarly research on the issue that transcends these differences.

Gender and the Science of Scientific Publishing in PNAS

Curious as to whether PNAS has fulfilled its potential as a venue for publishing scholarly research broadly relevant to the science community as a whole, I left front matter behind to survey the journal to see if it has indeed featured research on the science of scientific publication. It's necessarily a superficial survey, given the volume of the relevant literature, the space limitations of this editorial, and the limits of my expertise on this branch of science. I discovered that, from 1991 to February 2019, PNAS has published 227 articles with "gender" as a topic; a substantial fraction of these articles report research findings documenting gender-based differences in physiology, morphology, or behavior of organisms ranging from mice to fruit flies, which of course aren't relevant to any evaluation of the role of PNAS as a venue for publishing scholarly work on scientific gender bias. As a convenient shortcut in this decidedly nonsystematic survey, I winnowed the list down to include only 61 publications that included "gender" in the title. Of these, surprisingly, only 51 are research reports; eight are replies to other PNAS reports and two are opinion pieces. Clearly, the literature on gender bias, for want of a better phrase, inspires lively discussion and strongly held views.

Although the subject matter of the 61 publications is wide-ranging, one theme emerged as more prominent than most—namely, there's a preponderance of papers dealing with words and how they're used and interpreted. To cite a few examples, among the most frequently cited of PNAS papers on gender issues in science is Moss-Racusin et al. (6), an account of a double-blind study documenting a significant difference in the reaction of faculty to application materials for a laboratory position depending on randomly assigned gender-identifiable names. The paper titled "Science faculty's subtle gender biases favor male students," has been cited almost 700 times, averaging 86 citations per year. Implicit stereotypes also feature prominently in Nosek et al. (7), an examination of global associations of science with maleness and whether such stereotyping predicts nation-level gender differences in eighth-grade math and science achievement (it does). Nittrouer et al. (8) examined imbalances in gender representation in colloquium speakers at elite universities, analyzing 3,652 talks in six academic disciplines and, after controlling for other variables, demonstrated a skew toward male speakers. Atir and Ferguson (9) presented evidence that male professionals are more likely to be referred to by their surnames only, even when the professionals are fictional. Use of the surname only reflects a perception of greater fame and eminence; professionals referred to by surname are perceived to be "higher status and more deserving of eminence-related benefits and awards." Finally, Garg et al. (10) examined a century of word embeddings, a tool used in natural language processing and machine learning to depict semantic relationships among words, to show how changes in those relationships are associated with stereotypes over time; strikingly, a group of adjectives describing competence has shifted between 1960 and 1990 away from a strong male bias. If the small positive trend continues at the same rate, adjectival gender parity may be reached in just a few years.

Turning the Page on Gender Bias in Scientific Publishing

Overall, then, PNAS has indeed served as a venue for publishing studies addressing gender issues affecting the science community. Maybe I shouldn't have been surprised that so much attention in PNAS has been focused on communication issues; communication is fundamental to scientific progress, and, even though there are figures, tables, equations, and graphical abstracts, words remain essential elements of scientific publications. Whether traditional scientific journals continue their metamorphosis or whether they cease to exist, mechanisms are needed for the scientific community to make decisions about the value of any potential contribution to the literature. In that context, it isn't simply altruistic for journals to work toward decreasing gender bias in the editorial process; it's a strategic way to improve the quality of decision-making, and decision-making is, to some extent, the reason why editorial boards were created in the first place. There's growing evidence that increasing gender diversity of authorship teams can increase the quality of scientific publications [e.g., according to Campbell et al. (11), "peer-reviewed publications with gender-heterogeneous authorship teams received 34% more citations than publications produced by gender-uniform authorship teams"]. Increasing gender diversity of editorial boards may also yield "innovation dividends" (12) in terms of decision-making in all dimensions of the editorial process. Despite recent calls for crowdsourcing and postpublication reviewing, there remains great value in objective, trustworthy curation. PNAS aims to evaluate quality by scientific criteria that are recognized and for the most part accepted and thus aims to provide some assurance of quality. For this reason, the Editorial Board is structured so as to contain the expertise required to evaluate quality across a broad diversity of disciplines. Multidisciplinary science journals such as PNAS have both a special responsibility as well as a timely opportunity to take action to overcome implicit bias. We can amplify the actions

individual scientists can take to change STEM culture (13) by making a deliberate effort to incorporate gender diversity into editorial board structure, being cognizant of the value of diversity in the decision-making process, and recognizing and roguing out language bias in all aspects of the editorial process. Most importantly, we can continue to publish the highest-quality papers on the science of science publication to ensure that policies aimed at overcoming bias are evidence based.

As Kuhn (ref. 14, p. 209) aptly stated in his classic book *The Structure of Scientific Revolutions*, "Scientific knowledge, like language, is intrinsically the common property of a group or else nothing at all. To understand it we shall need to know the special characteristic of the groups that create and use it." Because the groups that create and use scientific knowledge include women, they must have a place in the curation and promulgation of that knowledge through the editorial process. For the record, though, in the entirety of Kuhn's transformational treatise on the nature of science, the word "woman" never appeared in the first edition; in the second edition, published 8 years later, it appears only once—and that's in the postscript.

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