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Editorial

Looking for a Few Good Women?

Great women scientists are invisible until someone specifically looks for great women scientists. Then they are plentiful. But no one has to look for great male scientists. Great male scientists always appear on lists of great scientists. This phenomenon was illustrated with painful clarity in this year's recipients of the Peter and Patricia Gruber Foundation's awards. For the second year in a row, the awardees in cosmology, genetics, and neuroscience are all men. This outcome is a stark counterpoint to the Gruber Foundation's demonstrated interest in young women in science, as indicated by their Rosalind Franklin Young Investigator Award. To grant this award, they look for great women scientists and they find them.

The Gruber Foundation is not alone. The distribution of awards by many other agencies and foundations reflects this pattern, but happily some deviate from it (Table 1). While the Lasker Foundation has consistently bypassed women among their finalists (1 woman among the last 19 awardees), and AAAS appears not to have ever recognized a woman-led research group with the Newcomb Cleveland Prize, The Howard Hughes Medical Institute Investigator competition, for example, consistently recognizes great women scientists. Through a highly rigorous review process, HHMI identifies scientists who are top notch by any measure (high impact discoveries, membership in the National Academy of Sciences, and Nobel Prizes), and in recent competitions they have awarded 25% of these prestigious investigatorships to women, which is proportional to the representation of women in the pool of biomedical scientists and engineers from which they draw. An interesting example of looking for and seeing great women scientists is the NIH Director's Pioneer Award. In the first competition, all nine were awarded to men, a decision that was greeted with shock and chagrin by many in the biomedical community (Carnes *et al.*, 2005). After changing the language in the call for nominations and reconfiguring the review process, every subsequent group of awardees has included women.

HHMI and NIH have looked for and consistently found outstanding women scientists. And so they should—over the last 20 years, women have received almost half of all doctoral degrees awarded in the life sciences, and women represent 32% of all tenure-track faculty and 26% of full professors in the life sciences (National Research Council, 2007). So by now, there are outstanding women scientists at all levels of biology. Elections to the National Academy of Sciences have ranged from 9% to 22% women in recent years, and a large proportion of these are in the life sciences (7% of the total members are women, but only 2–3% in the physical sciences, math, and engineering are women), so there is evidence of a solid supply of available female candidates at the senior, most accomplished levels of biomedical science.

What Goes Wrong?

Anecdotally, it is an interesting experience to review the recipients of these awards. Quite a few male names appear repeatedly as awardees in many different competitions, whereas few women's names do. Surely a woman who received the Nobel Prize in Medicine would be competitive for some of these awards? Shouldn't we expect some of the great women in the biomedical sciences who have been elected to the National Academy of Sciences to appear on the lists of Lasker Awards or as authors of papers selected for the Newcomb Cleveland Award? There is more driving these outcomes than simply a lack of strong women candidates.

Unintended Bias in Evaluation Processes?

We lack data to provide a definitive explanation of the gender distribution for each of these awards in the biomedical sciences, but there are abundant studies that are relevant to the analysis. The problem could lie with the people who make the decision about whom to nominate. It could also be that the quality of the letters written about women is lower than those about men. Or it could be a bias among the reviewers who choose the awardees. Studies from cognitive psychology suggest that bias likely creeps in at all of these points in the review process. Copious data show that most people harbor unconscious biases that influence their judgment of other people and their work. In randomized, blind experiments, evaluators assign lower ratings to candidates, worker's career progress, or productivity if they are told the person being evaluated is a woman than if they are told it is a man (Biernat and Kobrynowicz, 1997; Dovidio *et al.*, 1997; Heilman, 1980). In contrast, they assign higher scores for writing ability if they are told that a piece of text was written by a woman than if they are told it was written by a man (Biernat and Manis, 1994).

Research on scientists shows that we are not exceptions to the general population. A study in Sweden of postdoctoral fellowship awards explored possible reasons why women were awarded few fellowships in proportion to their representation in the applicant pool. The review panel

Table 1. Examples of Honors Awarded to Men and Women in Biomedical and Related Sciences since 2000

Award	*Time period analyzed*	*Number of awards to women*	*Number of awards to men*	*% to women*	*Years of no awards to women*
AAAS Newcomb Cleveland Prize	2000 to 2008	0[a,b]	13	0	all
Burroughs Wellcome Trust Investigators in Pathogenesis and Infectious Disease	2002 to 2008	20	54	27	
Howard Hughes Medical Institute Investigators[a]	2005 to 2008	25	74	25	
Lasker Foundation	2003 to 2007	1	18	5	2003, 2004, 2005, 2007
National Academy of Sciences	2005 to 2008	56	232	19	none
NIH Clinical Translational Science Awards	2006 to 2008	5	33	13	2006
NIH Director's Pioneer Award	2004 to 2007	13	34	28	2004
Nobel Prize in Physiology or Medicine	2000 to 2007	1	20	5	2000, 2001, 2002, 2003, 2005, 2006, 2007
Presidential Medal of Science	2000 to 2006	6[a]	50	11	2003, 2004, 2005

Most of these awards are in the biological sciences. Women represent 32% of all tenure track professors and 26% of full professors in the life sciences (National Research Council, 2007).

[a]This prize is awarded for a high impact research paper and it is difficult in some cases to identify the lead PI on the paper. However, to our knowledge none of the research groups awarded this prize were directed by women.

[b]These awards draw from pools of candidates that include fields such as engineering and chemistry, which have a lower representation of women than does biology.

assigned each candidate a score that indicated overall quality. Interestingly, the candidate's publication impact, a calculation that accounted for the number of papers and the quality of the journals in which they were published, was an almost perfect predictor of the panel's score of the male candidates. For women applicants, there was only a weak association between publication impact and the candidate's score. The authors concluded that a woman would need the equivalent of two to three more papers in *Nature* or *Science* and 20 more papers in a specialty journal to receive the same overall score as a man (Wenneras and Wold, 1997).

Unintended Bias in Reference Letters?

A linguistic study of letters of recommendation showed stark differences between letters written about women and men who were successful candidates for tenure-track faculty positions at a major medical school in the U.S. (Trix and Psenka, 2003). Referees' letters about women were much shorter than those about men, contained more references to women as "students" and "teachers" and more references to men as "colleagues" and "researchers," and contained four times as many references to women's personal lives. Since each of the candidates was offered a position, it is not possible to determine the impact of these differences on the selection of candidates, but there is clearly a difference.

Unintended Bias in Manuscript Review?

Review of scientific papers may also involve factors other than scientific quality. One recent study should be a wake-up call to all of us on the subject of peer review. The journal *Behavioral Ecology* conducted an experiment that demonstrated how double-blind review (in which neither the reviewers' nor authors' identities are revealed to each other) significantly increased acceptance of papers in which the first author was a woman. After controlling for confounding factors, the investigators concluded that double-blind reviews resulted in a 33% increase in the representation of women as first authors in the journal.

Untended Bias from Both Women and Men?

In all of the many studies showing that people are more likely to choose a male candidate over a female candidate with equivalent or even identical (in the case of the controlled studies) qualifications for a job, award, or promotion, male and female evaluators express the same bias. Although the sex of the candidate is significant in all of these studies, *the sex of the evaluator is significant in none of them*. This is important. We *all* carry unconscious biases, and they are truly unconscious, not intended. Empirical evidence indicates that men and women apply these biases with the same vigor, as there is often a good representation of women on the review panels that select only men as finalists. The Gruber Foundation's selection boards, for example, contain a solid representation of senior women scientists. A necessary and laudable first step, but not sufficient.

How Do Fair Men and Women Justify Biased Evaluations?

Most of us strive to be objective in both our scientific investigations and our evaluations of people. In fact, many scientists fancy themselves as being completely objective and would balk at the idea that they are applying standards other

than quality to their evaluations of people and their work. Research shows that most people want to be, intend to be, and consider themselves to be fair. But many of us fall short of this goal. So how do we justify our evaluations that are affected by bias? In one randomized study, evaluators were asked which candidate they would hire and why after reviewing resumes that were assigned either a man's or woman's name. The evaluators were more likely to hire the man, independent of which resume had the man's name on it. When asked for their reasons, they cited whichever element (education or experience) was stronger on the man's resume as the most important element in their decision (Uhlmann and Cohen, 1997). Apparently we are quite adept at justifying biased evaluations.

What Can Be Done?

Examination of the available data on bias leads to the uncomfortable conclusion that women are disadvantaged at every stage—it is harder for them to get their papers published, and their work, even when it is published, is valued less than the same work from men. The accumulation of bias at so many stages of careers can lead to large differences in outcomes to award selections such as those shown in Table 1.

How then do we act on our intention to be fair and choose the best candidates or work, rather than act on centuries of cultural bias? The answer is rigor. In scientific experimentation, we should ask, "Is there another control we should run?" "How might I be seeing what I want to see rather than what the data are telling me?" "Is there an alternative interpretation to these data?" In evaluation of people and their work, we should be applying the same type of rigor. Rather than accepting gut-level judgments without reflection, we need to include a similar set of questions in every review process. "What are our criteria for selection?" "Are we holding all of the candidates to the same standards?" "Are we being fair?" Although these appear to be the type of rigorous questions that any careful scientist would embrace, they are rarely asked, and when they are, they are frequently greeted defensively and dismissed.

To achieve balanced reviews and equitable recognition of all scientists regardless of gender, awarding foundations must form their selection committees carefully, educate them about unconscious bias, and teach them how to avoid applying these biases in their decisions. With some conscious attention to the issue, unconscious biases can be overcome, as demonstrated by the history of the NIH Director's Pioneer Award.

So what are the steps we should take to ensure fair and objective review leading to the best science being published and recognized? How do we implement the explicit criteria that we intend to use and not introduce criteria that have no relevance to our goal of excellence? Four changes would make a huge difference:

1. All journals should use a double-blind review process.
2. For award nominations, if women are not represented appropriately in the pool of candidates, the director of the competition should actively encourage universities to submit women candidates.
3. Selection committees should be briefed on the impact of unconscious bias.
4. Chairs of selection committees should ask the committee to review its work periodically and consider whether the process has been fair, whether all candidates were held to the same standards, and whether factors other than quality entered into their decisions.

We applaud the Gruber Foundation's commitment to the recognition of young women scientists. Early support remains critical to attracting and encouraging young women. But we need to extend our recognition of women to those awards not specifically designated as being for women only. We need to look for great women scientists, and if we use a rigorous process of review, we will see them. Lots of them.

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