

The Matilda Effect in science: Awards and prizes in the US, 1990s and 2000s

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Abstract

Science is stratified, with an unequal distribution of research facilities and rewards among scientists. Awards and prizes, which are critical for shaping scientific career trajectories, play a role in this stratification when they differentially enhance the status of scientists who already have large reputations: the 'Matthew Effect'. Contrary to the Mertonian norm of universalism – the expectation that the personal attributes of scientists do not affect evaluations of their scientific claims and contributions – in practice, a great deal of evidence suggests that the scientific efforts and achievements of women do not receive the same recognition as do those of men: the 'Matilda Effect'. Awards in science, technology, engineering and medical (STEM) fields are not immune to these biases. We outline the research on gender bias in evaluations of research and analyze data from 13 STEM disciplinary societies. While women's receipt of professional awards and prizes has increased in the past two decades, men continue to win a higher proportion of awards for scholarly research than expected based on their representation in the nomination pool. The results support the powerful twin influences of implicit bias and committee chairs as contributing

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factors. The analysis sheds light on the relationship of external social factors to women's science careers and helps to explain why women are severely underrepresented as winners of science awards. The ghettoization of women's accomplishments into a category of 'women-only' awards also is discussed.

Keywords

awards, gender, ghettoization, implicit bias, Matthew Effect, prizes, science, universalism

It has long been recognized that science is stratified, with research facilities and rewards unequally distributed among scientists (Zuckerman, 1970). This 'Matthew Effect' results in the disproportionate recognition to the work of scientists on the basis of their current renown, such that the efforts of well-known scientists are more visible while the contributions of the less well-known are less visible (Merton, 1968). Ultimately, these advantages accumulate among persons who have already received recognition and contribute further to their reputations.

Contrary to the Mertonian norm of universalism – the expectation that scientific claims and contributions are evaluated apart from the personal attributes of scientists – a great deal of evidence suggests that women's scientific efforts are devalued compared with those of men (Long and Fox, 1995). While overt discrimination in American society is declining, women's efforts continue to be perceived as less important or valuable than those of men. A large body of social science research finds that work done by women is perceived as less important or valuable than that done by men (Goldin and Rouse, 2000; Heilman and Haynes, 2005; Wenneras and Wold, 1997). Indeed, in this journal 19 years ago, Rossiter (1993) identified the 'Matilda Effect', by which women and their scientific contributions are credited to men or overlooked entirely. The 'Matilda Effect' is perhaps nowhere more starkly illustrated than in the experience of Ben Barres (2006), who documented the different reception of his work as a female neurobiologist prior to his sex-reassignment surgery in 1997 at age 42 years. In addition to becoming privy to conversations that denigrated female scientists' abilities in general, as a man he reported being told about the perception that research done by his 'sister' Barbara – his name prior to surgery – was weaker than work done by Ben. Importantly, research finds that men do not have a monopoly on gender bias. In fact, both men and women evaluate men more favorably than they do women, even when they have identical credentials (Correll et al., 2007; Steinpreis et al., 1999).

A key measure of scientists' stature, evaluation of their scholarly research, is not immune to the Matilda Effect (Barres, 2006; Budden et al., 2008). One case in point is that, in 2001, the journal *Behavioral Ecology* switched from a single-blind manuscript review process, in which reviewers know the names of manuscript authors, to a double-blind process, in which neither reviewers nor authors know the other's identity. While the double-blind model is common in many of the social sciences, in many disciplines in the life and physical sciences, medicine, and engineering, it is more common to employ single-blind review. Consequently, the implementation of the new editorial policies provided a natural experiment to test the effects of knowing the author's identity on reviewers' judgments. Budden et al. (2008) attributed the subsequent 7.9

percent jump in manuscript acceptance rate of articles first-authored by women directly to the change in review policies.¹

Awards and prizes are close cousins of peer-reviewed publications, as they provide important external markers of professional achievement and are instrumental for shaping and advancing careers (Frey, 2007), including promotion and tenure decisions, and are another measure by which scientific work is accorded value and disciplines are shaped. Yet, while there has been a substantial increase in the number of women receiving doctoral degrees in science, technology, engineering, and mathematics (STEM), and women are an increasingly important part of the scientific and professional work force, the RAISE Project concludes that women are significantly underrepresented as recipients of prizes for their research.²

In this paper, we briefly outline the literature on gender disparities in evaluation in science and mathematics and examine the distribution of awards and prizes to men and women, including the contribution of a candidate's gender to award outcomes. Finally, we provide suggestions on how to reduce implicit bias – such as habitual associations of men with science and women with liberal arts (Greenwald et al., 2003) – and policies that disciplinary societies can adopt to promote greater equity and engagement of women in the STEM professional work force.

Gender disparities in scientific awards and prizes

The typical explanation for the low proportion of women receiving STEM awards invokes the notion of a 'pipeline'. This is the idea that women have only recently entered these fields in substantial numbers, particularly since Title IX was passed in 1972, so that the number of eligible women at the pinnacle of their careers is lower than the number of men (Xie and Shaumann, 2003). Followed to its logical conclusion, this idea would predict that, as more women enter science, the proportion of women receiving awards should increase, gradually approaching the percentage of men receiving the relevant awards. However, while there has been a substantial increase in the proportion of women receiving doctoral degrees in STEM fields, the proportion of women receiving prizes remains low (RAISE Project). Indeed, a PhD does not guarantee full participation in an academic field. For this reason, it is useful to have estimates of the pool of eligible candidates for scholarly recognition, along with information about characteristics (including gender) of the candidates and the types of awards for which they are considered eligible.

A growing literature documents a host of factors that disadvantage women for receiving awards, beginning with the call for nominations. Experimental research demonstrates that cultural beliefs about differences in the capabilities of women and men influence self-assessments of ability (Correll, 2001); consequently, women are less likely than men of equal abilities to self-promote or seek nominations from others (Fiorentine, 1987; Rudman, 1998). In addition, the prize criteria themselves evoke images, stereotypically associated with men, when describing appropriate candidates, often using language such as 'leaders' or persons who 'take risks' (Carnes et al., 2005). Letters of recommendation for female nominees tend to be shorter, mention the candidate's gender and personal life, contain fewer descriptors of exceptional qualities, use stereotypically female adjectives

such as ‘compassionate’, and include more negative language likely to raise doubt about the applicant (Trix and Psenka, 2003).

After a nomination is submitted to an award committee, demographic processes may influence the evaluation process. In particular, demographically diverse groups are more open to different ideas than homogeneous groups, due to ‘cognitive resources that are valuable for new ideas and may offer different perspectives on any given issue’ (Tsui and Gutek, 1999: 86; for an equivocal view, see Horwitz and Horwitz, 2007). For example, Lincoln et al. (2009) found that in a physics society the presence of each woman on an award committee doubled the chances of a woman winning an award, and that committees chaired by women were three times more likely than those chaired by men to name a woman as a winner. However, demographically diverse groups can also be marked by lower group cohesion and greater interpersonal conflict (McLeod et al., 1996; Tsui and Gutek, 1999). These findings identify a complex series of hurdles facing those who make efforts to improve impartial review and recognition of women’s achievements in STEM fields.

With these findings in mind, we conduct two sets of analyses. First, we examine the evidence for the pipeline thesis – that the proportion of women receiving awards has increased between the 1990s and the 2000s due to the increase of women in the senior ranks in STEM fields. We then turn to the awards process itself to examine the nomination and committee factors that influence the selection of women.

Data and methods

We collected publicly available data on the awards bestowed by 13 disciplinary societies in the physical sciences, biomedical sciences, and mathematics between 1991 and 2010.

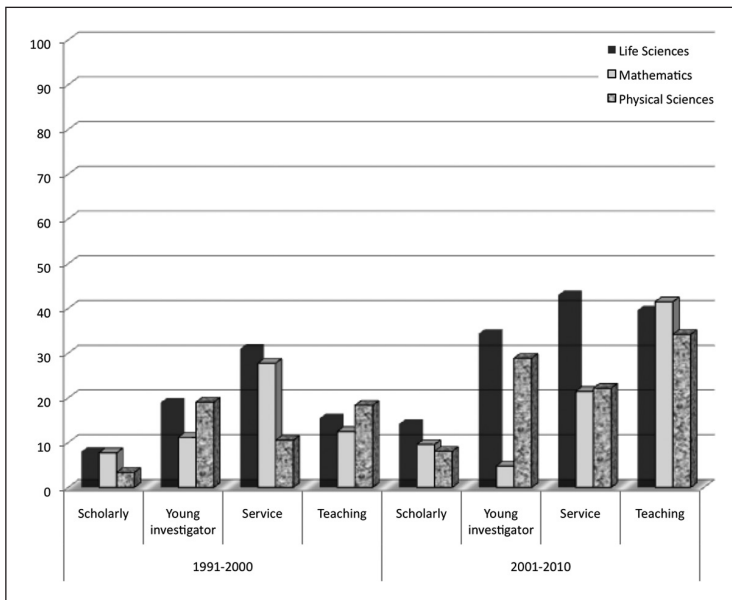


Figure 1. Percentage of female winners by award type and field, 1991–2010

Table 1. Distribution of awards and prizes in 13 stem disciplinary societies by award type, 1991–2010

	1991–2000	2001–2010
Awards (n)	206	296
Recipients (n)	1924	2865
Female recipients (n)	230	516
Scholarly awards (%)	67.0	60.8
Young investigator awards (%)	12.1	17.9
Service awards (%)	11.7	11.8
Teaching awards (%)	8.3	8.1
Woman-only awards (%)	1.0	1.4

Excluding prizes that were restricted to female recipients, as well as travel awards, student awards, and several awards that were otherwise unclassifiable, the 13 societies offered 206 prizes to 1,924 recipients between 1991 and 2000. By 2010, that number had grown by 43.2 percent to 296 prizes bestowed upon 2,865 persons. The prizes can be assigned to one of three categories: service to the discipline or the society; teaching/education/mentoring; and scholarship, discovery, or research. The last category is the largest and most prestigious type of award, and can be expected to have the most profound effect on professional advancement. A significant fraction of scholarly awards is devoted specifically to the research of junior scholars, and so we report the two categories separately (see Table 1).³ As Figure 1 shows, while women received service and teaching awards relatively frequently, they were recognized for their research far less frequently.

Following consultation with the women's committees of 23 STEM disciplinary societies about recognition for the women in their societies, we sought the societies' cooperation with our project's effort to examine the process by which nominees are evaluated for awards. Seven societies agreed to cooperate: four mathematics or mathematics-related societies, two from the physical sciences, and one from the life sciences. These seven societies have a total membership of more than 330,000 and distribute close to 200 awards and prizes each year.

The typical nomination and evaluation practices employed by the societies are very similar. The norm is for a separate committee to handle each award, with membership on some award committees extending for multiple years. Each prize committee operates in isolation, without any guidelines other than conflict-of-interest and stated criteria for the award, and there is usually little oversight of committee activities. Committees tend to be comprised of three or more (typically between three and five) members appointed by the society leadership, with a chair appointed by the society president. Previous prizewinners are commonly part of the committee, or are asked to submit names of nominees. While commonly governed by standard conflict-of-interest guidelines, committees usually work in a confidential manner that is unlikely to uncover any personal conflicts. None of the committees we examined remove identifying information from candidates' nomination packets. Materials used to evaluate each candidate usually

include the curriculum vitae and one or more letters of support from a third-party nominator. The candidate pool for each award tends to be small, in the range of 10 to 20 persons, probably due in part to the nomination process. Specifically, nominations tend to be solicited passively, through advertising and posting on the society website, though some of the societies also rely on word of mouth and personal outreach.

Several of the societies were able to provide detailed data on the nominee pool and on the selections made by committee members for awards and prizes since 2000. We categorized the awards by type (scholarly, young investigator, service, teaching, and woman-only), the year each was offered, the winner's gender, and when available, the size and gender composition of the nomination pool and committee, including the chair.

Results

Is there a pipeline for awards?

To address the question of whether lower rates of scholarly recognition for women have a temporal component for women to reach the upper ranges of a discipline's hierarchy in order to be eligible for awards, we first compared the percentages of women who won each society's awards in 1991–2000 and 2001–2010. Awards to women did, in fact, increase by 78.5 percent from the earlier to the later decade. Closer analysis shows that women continued to win far fewer of the more prestigious scholarly awards than the other types of awards, however – averaging just 10 percent. By comparison, women won 32.2 percent of service awards and 37.1 percent of teaching awards between 2001 and 2010. We use multivariate regression analysis to provide a more detailed overview of the relationships.

Table 2 presents the beta coefficients for the ordinary least squares regression analysis of the percentage of female award winners in each of the two decades covered by this study. Beta coefficients are standardized, meaning that all variables have been transformed to standard scores with a mean of zero and a standard deviation of one; thus, their coefficients are directly comparable in terms of effect size. The dependent variable was log-transformed due to skew. The omitted (reference) category is teaching awards. The first column shows that the proportion of women who won scholarly awards in the 1990s – but not service or young investigator awards – was significantly lower than the proportion that won teaching awards. There was, however, no statistically significant difference between the percentage of women who won young investigator or service awards compared with awards for teaching.

Despite growth in award recognition for women between the 1990s and the 2000s, women continued to win a relatively small percentage of awards for scholarly research compared with teaching awards (column 2). Contrary to the pipeline thesis, this disparity grew in the 2000s, indicating that women's representation among research award recipients was smaller relative to teaching awards than in the previous decade. Between 2001 and 2010, women also won a significantly smaller proportion of awards for young investigators in the mathematical societies than in the previous decade.⁴ In contrast to the descriptive statistics in Table 1, the regression analysis in Table 2 paints a starker picture of a pipeline for awards, showing that the gains made by women have not been equally

Table 2. Beta coefficients of the ordinary least squares (OLS) regression of predictive factors on the proportion of female award winners in disciplinary societies^a

	1991–2000	2001–2010
Scholarly awards		
Life sciences	–0.269**	–0.315***
Mathematical sciences	–0.264**	–0.491***
Physical sciences	–0.526***	–0.623***
Young investigator awards		
Life sciences	0.073	–0.049
Mathematical sciences	–0.068	–0.288***
Physical sciences	0.038	–0.107
Service awards		
Life sciences	0.105	–0.013
Mathematical sciences	0.056	–0.065
Physical sciences	–0.119	–0.147*
R ²	0.275	0.277
Adjusted R ²	0.242	0.254
N	204	292

Note: Models exclude awards restricted to women. Omitted (reference) category is teaching awards.

^aNatural log.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

distributed across the different prize categories. That is, growth in women's receipt of teaching awards outpaced gains made for scholarly research. We turn to the award nomination and selection process to interrogate the factors that contribute to women's chances of winning.

The award process

The data for this part of the analysis represent prizes awarded by four of the societies to 518 recipients between 2000 and 2010 (Table 3). The average committee is composed of 5.9 members, with 1.4 women (19.5 percent of the average committee membership). Men chaired 94 percent of the committees, and 120 prize committees (42.0 percent) had no female members at all. Prize committees typically received 24 nominations for each yearly award. On average, 17.1 percent of the nominees were women, and women won 17.1 percent of awards.

The Matilda Effect – and a great deal of social science research – posits that research done by women tends to be overlooked in favor of that of men, which is more likely to be singled out as notable. To test for this effect, we conducted a logistic regression analysis for the odds that a man will win scholarly and young investigator awards (controlling for year, prize, and field; woman-only awards are excluded; see Table 4). In logistic regression (an appropriate technique to use when the dependent variable is dichotomous), coefficients larger than 1 represent higher odds of the outcome occurring – in this case, the odds of a man winning – while coefficients smaller than 1 indicate lower odds

Table 3. Descriptive statistics for award committees, 2000–2010

Variable	Mean (SD)	Range
Female winners (%)	17.1 (37.7)	0–100
Total nominees (all years, all awards)	24.0 (27.0)	1–98
Female nominees (%)	17.1 (18.5)	0–100
Committee size (n)	5.9 (2.7)	2–10
Male chairs (%)	94.0 (0.2)	0–100
Women on committee (n)	1.4 (1.6)	0–5
Women on committee (%)	19.5 (20.1)	0–71.4
No women on committee (%)	42.0	
Committees with one woman (%)	10.6	
Committees with two women (%)	2.3	

Note: Excludes awards restricted to women only.

Table 4. Logistic regression of male winner (odds ratios), 2000–2010

	Model 1	Model 2	Model 3	Model 4
Year	0.891	0.927	0.749**	0.808
Prize	1.012	1.002	1.001	1.009
Award type				
Scholarly	8.268***	2.081*	1.194	2.947
Young investigator	2.877*	1.930	0.839	–
Discipline				
Mathematics societies	0.282*	0.991	1.203	0.174
Life science societies	0.226*	1.263	–	–
Female nominees (%) ^a	–	0.256***	–	–
Female committee (%) ^a	–	–	0.707*	0.995
Male chair	–	–	–	8.628*
n	518	518	285	216
Pseudo R ²	0.136	0.287	0.154	0.105

Note: Excluded (comparison) categories are service and teaching awards and physical science awards.

Note: Analysis excludes awards restricted to women only.

^aNatural log.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

of the outcome occurring. The omitted (comparison) category is service and teaching awards. Between 2000 and 2010, men were more than eight times more likely than women to win a scholarly award and almost three times more likely to win a young investigator award.

These same four societies reported information on the gender composition of the nomination pool. Consistent with the Matilda Effect, men are twice as likely to win an award for scholarly research regardless of their representation in the nomination pool (Model 2). This may be due in part to committee composition; a higher percentage of

women on the committee benefits women's odds of winning (Model 3).^{5,6} Committees chaired by men, however, are significantly less likely to award prizes to women, and male chairs trump any effect of women on the committee (Model 4).^{7,8} Indeed, committees chaired by men awarded prizes to men 95.1 percent of the time, despite the fact that women comprised 21 percent of the nomination pool considered by those committees, a significant difference $\chi^2(1, N=216) = 7.12, p = 0.008$. By comparison, under committees chaired by women, women won 23.1 percent of the time and comprised 33 percent of the nomination pool. Part of this is because women seem equally likely to chair committees for scholarly awards (53.9 percent) and for service and teaching (46.2 percent), while men are significantly more likely to chair scholarly award committees (89.2 percent) than committees that award prizes for service and teaching (10.8 percent) $\chi^2(1, N = 216) = 13.60, p < 0.001$. Too few societies retained both information on the gender of the committee chair and the composition of the nomination pool for analysis ($n=46$).

Discussion

The pipeline thesis that it is simply taking time for women to wend their way into the highest echelons of scientific achievement has merit. In the two decades between 1991 and 2010, women's representation as recipients of scientific awards and prizes nearly doubled. Closer analysis, however, shows that despite this growth, women won a significantly smaller proportion of prizes for scholarly research than they did for service and teaching, both as senior scholars and as young investigators. Moreover, this disparity grew between the two decades, rather than diminishing as predicted by the pipeline thesis (Xie and Shauman, 2003). Put another way, the pace of women's receipt of teaching awards outstripped growth in recognition for women's scholarly research. In addition, we find that men are more likely than women to win scholarly awards regardless of the proportions of men and women in the nomination pool. Thus, while improving women's representation in the nomination pool does improve their odds of winning – and it does so roughly fourfold – it is insufficient to overcome other factors that appear to downgrade the evaluation of women's research. Female representation on prize committees, especially as chairs, appears to moderate some of the disparity.⁹

Ghettoization and women-only awards

The increase in the number of awards restricted to female recipients merits special attention. These awards were initiated to combat the biases outlined above by taking specific note of the scientific contributions of women. On the face of them, awards for women may not raise concerns. Indeed, a host of awards, such as early scholar awards, lifetime achievement awards and awards for minorities, are restricted to ascribed characteristics of their recipients. Yet women-only awards can camouflage women's underrepresentation by inflating the number of female award recipients, leading to the impression that no disparities exist. This effect is heightened in disciplines in which women are severely underrepresented. For example, of awards given by the American Physical Society, Lincoln et al. (2009) found that including awards restricted to women increased the proportion of female winners of that society's awards by 55 percent, from 4.2 to 6.5 percent.

Table 5. Comparison of four societies that offer awards restricted to women

2001–2010	A	B	C	D
Awards (n)	240	108	132	90
Female winners (n)	63	22	51	16
Percentage of women winning	26.3	20.4	38.6	17.8
Percentage of women winning excluding women-only awards	19.9	12.2	35.6	7.5
Difference (percentage points)	6.4	8.2	3.0	10.3
Inflation by women-only awards (%)	32.2	67.2	8.4	137.3

While some societies in the present study do not award prizes for women only, including such awards in tallies can substantially raise the proportion of female winners in professional societies that do. For example, women won 22 of the 108 awards bestowed between 2001 and 2010 in one society, or 20.4 percent. However, 10 of the awards were for women only, meaning that women won only 12.2 percent of the unrestricted awards, a 67 percent reduction. Table 5 shows the range of variation in four of the societies between percentages of awards given to women when women-only awards are included or excluded from the tally.

When the bulk of awards won by women are restricted to women candidates, the effect may be to marginalize women's research. Recall that research suggests that women and men both assign lower value to work done by women. Awards to women only, then, may implicitly support the cultural belief that women's scientific efforts are not as important as those of men, thus contributing to the 'ghettoization' of women's scientific achievements, perhaps even leading to the oversight of women as candidates for unrestricted awards. Borrowed from the literature on racial/ethnic social and residential segregation, the term 'ghettoization' has been used in studies of the consequences of women entering an occupation that was previously male-dominated. One such consequence is that women come to dominate the lower-paying, less-prestigious specialties within the occupation (Reskin and Roos, 1990). Within an academic discipline, ghettoization can also mean that scholarly efforts are disseminated primarily among female scholars and researchers (see, for example, Grant and Ward, 1991). Indeed, a similar critique has been levied at sociology. The 'balkanization' of research in sociology has led to smaller subdisciplines investigating the same social processes and mechanisms, to the detriment of broader theoretical understandings of social processes (Reskin, 2003). Future research should direct attention to awards restricted to women, particularly their relationship to nomination and awarding of unrestricted prizes for scholarly research to women.

Conclusion

This paper contributes to the systematic analysis of the gender distribution of scientific awards and prizes. Our findings suggest that the 'Matilda Effect' persists – men receive an outsized share of scholarly awards and prizes compared with their representation in the nomination pool, despite efforts to increase nominations of women. That is, though

some awards have few female nominees, the evidence suggests that women are not winning not because they are not being nominated. Rather, although overt gender discrimination generally continues to decline in American society (Blau et al., 2006), our research is consistent with other studies that document the culturally held belief that women's scholarly efforts are less important than those of men. A consequence of this belief is that women continue to be disadvantaged with respect to the receipt of scientific awards and prizes, particularly for research.

The findings in this paper suggest possible remedies for the underrepresentation of women as recipients of science awards and prizes. First, having more women represented in the nomination pool is important. Our findings imply that increasing the proportion of women nominated for awards should increase the percentage who win prizes. Such increases will require a conscious effort on the part of prize committees, especially when men predominate in such committees and give more favorable evaluations to people like themselves (McPherson et al., 1992). Information networks tend to run along gendered lines, with women distributing information to other women and men to other men (Drentea, 1998; Granovetter, 1973, 1985). When male committee members seek nominees, they are thus more likely to contact other men, rather than women. Consequently, ensuring that women are on prize committees, especially as chairs, is particularly important.

Beyond these basic steps, what can be done to counteract implicit bias in the award process? Given the broader cultural context in which it arises, implicit bias may never be fully eliminated, but a series of steps can minimize its effects. First, professional societies must inform leadership and awards committees about such bias. The portfolio of awards should be reviewed regularly to ensure appropriate recognition of newer sub-disciplines that frequently attract more women, such as bioengineering and biochemistry (National Academies, 2006). Award criteria should be reviewed for biased language and answers to explicit questions about nominees should be solicited rather than open-ended letters of recommendation. In addition, an oversight committee should maintain standards for awards committees. At the committee meeting itself, members should consider the possibility of implicit bias and review important criteria before the review of nominees begins. The fact that women are honored twice as often for service as for scholarship may arise from the implicit bias of 'role incongruity', the tacit assumption that scientists and rigorous scholars are men, and that women are incongruent with the scientist role (Heilman and Haynes, 2005). The findings, however, suggest that for scholarly awards, such bias is moderated somewhat by women's presence in the nominee pool. Ultimately, incorporating these practices should offset many of the effects of implicit bias.

Notes

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1. An earlier study of acceptance rates at *American Economic Review* found some support for the benefits to women authors of double-blind review, but the sample size was too small to reach statistical significance (Blank, 1991).
2. The RAISE Project, a program sponsored by the Society for Women's Health Research, recognizes women's achievements through maintenance of a database of awards and prizes by sex, discipline, and career rank of recipients (www.raiseproject.org).

3. We used a data-driven approach and classified an award as being for a young investigator if the society classified it as such. Young investigators were defined differently by different societies, including by age and by years since PhD.
4. These findings hold for within-field analyses (life science, physical science, or mathematics/related). For the sake of brevity, we have not shown these analyses here.
5. Models conducted with number of women on the committee (no women, one woman, two women, two-or-more women) were not significant (we omitted these for brevity). The table is available upon request.
6. The *n* decreases between Models 2 and 3 because there is incomplete overlap between the societies analyzed and the data they provided. One society in Model 2 reported its nomination pool but not its committee members, while another society reported its committee members but not its nomination pool.
7. In Models 4 and 5, young investigator and service awards are too few to be used as separate categories; therefore, the reference (omitted) category is a combination of young investigator, service, and teaching awards.
8. The dichotomous chair variable means that inversely, committees chaired by women are significantly more likely (on the order of nine times) to award a prize to a woman.
9. Indeed, this analysis can only address the quantity of nominations from men and women, not their quality.

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