

Who Resembles a Scientific Leader—Jack or Jill?

How Implicit Bias Could Influence Research Grant Funding

When women advance in medicine, so does women's health. In cardiology, women have led major research studies examining and confirming sex differences in cardiovascular disease risk factors, manifestations, and outcomes, providing essential data for evidence-based approaches to women's heart health. The inclusion of women in cardiovascular research studies paralleled the entry of women physicians into cardiology. When women were absent as principal investigators, women were also missing from the tens of thousands of participants in the early cardiovascular prevention trials, including the Coronary Drug Project, Physicians Health Study, Lipid Research Clinics Coronary Primary Prevention Trial, and Multiple Risk Factors Intervention Trial (so-called MR FIT).

Given the association between women entering cardiology and research in women's heart health, it is worrisome that women comprise <20% of cardiologists (the lowest percentage among internal medicine subspecialties).¹ Furthermore, although female cardiologists are more likely than their male peers to practice in academic settings where most research is conducted (43% versus 34%), they are less likely in these settings to be involved in research² or achieve the rank of full professor,¹ and more likely to report lower levels of career attainment.² Because conducting research as an independent investigator is critical for academic career advancement,³ and holding National Institutes of Health (NIH) grants is associated with the rank of full professor,¹ it is important to examine NIH research award success by sex, in particular R01 awards, the gold standard of independence. With some exceptions, studies find no difference in overall award rates for men and women applying for NIH R01 (or R01 equivalent) awards (see [Table I in the online-only Data Supplement](#)). However, studies that examine new (type 1) and renewal (type 2) awards separately consistently find that women have lower type 2 success rates. Data from NIH confirm equivalent success rates for men and women applying for type 1 awards, but higher success rates for men's type 2 awards by ≈4% for nearly 20 years.

Blumenthal and colleagues¹ found that female cardiologists are less likely to hold the rank of full professor than their male counterparts. In their data, male and female cardiology faculty were equally likely to hold an NIH grant overall, but women held significantly fewer NIH grants between the associate and full professor ranks. This is exactly where the consequences of the sex differences in R01 renewals would manifest, because failing to renew an R01 could prevent female cardiologists from advancing to full professor. Specifically, if female and male cardiology faculty are equally likely to obtain a type 1 R01 award and launch an independent research program, they are equally likely to advance from assistant to associate professor. If women are subsequently less likely than their male peers to maintain their research program by renewing their R01s as type 2 awards, women will be less likely to advance to full professor. The negative impact of this sex gap

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in NIH type 2 renewals is 2-fold. A talented group of female cardiologists is blocked from attaining sequential leadership roles as division head, chair, or dean, robbing cardiology and all academic medicine of their vital perspectives, and the pool of investigators most likely to lead research on cardiovascular disease in women is diminished.

The reason women are less successful than men in renewing their R01 awards is unknown. It is possible women more than men investigate areas of lower funding priority or that women conduct lower-quality research. However, irrefutable evidence demonstrates that the mere existence of sex stereotypes can unintentionally and unwittingly invoke implicitly different referent standards when judging the identical performance of a man or woman. Women are most disadvantaged by such implicit bias when being evaluated in roles that are more strongly associated with men than women.⁴ Implicit Association Tests confirm that both science and leadership are more strongly associated with male-gendered than female-gendered names.⁴ If implicit sex bias were to influence scientific peer review of R01s, it would most likely occur in review of type 2 awards, because successful applicants must be considered scientific leaders. Reviewers would implicitly invoke different referent standards for men and women in the evaluation of their performance as both a scientist and a leader, doubly disadvantaging women.

Our research group has begun to examine R01 reviewers' written critiques as a window into their decision-making processes. We have found evidence that implicit sex bias could be operating in the review of type 2 R01s in 2 studies evaluating samples of critiques from investigators at the University of Wisconsin. We found that, given the same priority score, critiques for applications from women contained significantly more words of praise, whereas those from men contained more negative evaluation words. In a second sample, we found no difference in scoring or descriptors in critiques of men's and women's type 1 applications. However, women's type 2 applications had significantly worse priority scores than men's, even though more critiques of women's applications had standout adjectives (eg, excellent, outstanding) and words about their ability. These studies are consistent with the implicit application of different referent standards when evaluating R01 renewals, depending on the applicant's sex. However, experimental studies are needed to confirm whether implicit sex bias contributes to observed disparities in type 2 funding. In the meantime, avoiding semantic priming of male-gendered stereotypes is one practice that appears to reduce implicit bias. When NIH replaced male-gendered semantic primes (eg, high risk, technological breakthroughs) in the solicitation and review instructions for the NIH Director's Pioneer Award,

women recipients increased from zero in 2004 to an average of ~30% in the ensuing 12 years.

Fortunately, NIH is currently undertaking a large experimental study to explore whether implicit bias enters the peer review process, and our team at the University of Wisconsin is concurrently conducting an experimental study assessing the effect of manipulating demographics of R01 applicants on the same applications. These are challenging undertakings given the amount of randomness and subjectivity involved in scientific peer review.⁵ However, if implicit bias is found to be influencing type 2 award success rates, then interventions can be developed, tested, and implemented.

ARTICLE INFORMATION

The online-only Data Supplement is available with this article at <http://circ.ahajournals.org/lookup/suppl/doi:10.1161/CIRCULATIONAHA.117.031295/-DC1>.

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SUPPLEMENTAL MATERIAL

Who Resembles a Scientific Leader – Jack or Jill? How Implicit Bias Could Influence Research Grant Funding

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Table 1. Studies or Data Examining Gender Differences in Review and Outcomes of NIH Grants that Included R01 Awards

Study or Dataset	Significant Findings	Comment	Reference
Gender differences in research awards for 4 federal agencies including NIH (2001-2003)	For NIH (after controlling for age, degree, type of institution, and removing top 1% of awards), women vs. men: <ul style="list-style-type: none">Less likely to receive awardLower award size	<ul style="list-style-type: none">Did not separate out new (Type 1) and renewal (Type 2) R01sWomen were less likely to submit another proposal within 2 years than men	Hosek SD, et al. RAND Corporation. 2005. http://www.rand.org/pubs/technical_reports/2005/RAND_TR307.pdf
Award rates for male and female investigators for 6 NIH award categories (2003-2007)	Lower success rates for women vs. men: <ul style="list-style-type: none">R01 for first time MD applicantsK01s for MD/PhDsR01s to experienced investigators	<ul style="list-style-type: none">Significantly fewer women than men applyingWomen physician's lower R01 success rates for experienced investigators will include Type 2s and can prevent academic career advancement	Ley T, Hamilton BH. <i>Science</i> . 2008; 322(5907):1472-1474.
National cohort of K08 and K23 career development awardees examined for subsequent R01 funding (1997-2003)	Women were less likely than men to hold an R01 at 5 and 10 years after their K-award	<ul style="list-style-type: none">Whether women's lower rate of R01 award achievement is due to lower rates of application or lower rates of success in application could not be determined	Jagsi, et al. <i>Ann Intern Med</i> . 2009; 151(11):804-811.
Award rates for male and female investigators in 17 NIH award categories (2008)	Generally women preformed as well as men and direct costs were comparable However, lower success rates: <ul style="list-style-type: none">For men applying for F31 (pre-doctoral fellowships)For women renewing R01s (Type 2)	<ul style="list-style-type: none">Women's greater success rates than men at early career stages argues against differential talent or research interestLower success rate for Type 2 R01 renewals affects women on the threshold of eligibility for advancing to top leadership in academic medicine	Pohlhaus, et al. <i>Acad Med</i> . 2011; 86(6):759-767.
Examined NIH grant funding to faculty in otolaryngology departments (2011, 2012)	<ul style="list-style-type: none">Women significantly less likely to have R01s than menIndividual NIH awards to men were higher than those to women	<ul style="list-style-type: none">Did not separate new Type 1 and Type 2 renewal R01s	Eloy JA, et al. <i>Otolaryngol Head Neck Surg</i> . 2013; 149(1):77-83
Examined success of K-awardees in obtaining any R-level at Johns Hopkins (1999-2012)	No gender difference found		Kalyani RR, et al. <i>J Women's Health</i> . 2015; 24(11):933-939
Text analysis of 454 critiques from R01s originally unfunded and subsequently funded in 2008 from 67 investigators at the University of Wisconsin	<ul style="list-style-type: none">For the same scores and funding outcomes - women's R01s had more words of praise and those from men's R01s which had more negative evaluation wordsCritiques with greatest differences were for Type 2	<ul style="list-style-type: none">Critique format in 2008 had more free text than the post 2009 formatFindings suggest that gender stereotypes might operate in R01 peer review	Kaatz A, et al. <i>Acad Med</i> . 2015; 90(1):69-75.
Test analysis of 739 critiques of R01s funded 2010-2014 with critiques of previously unfunded applications for those not funded the first time from 125 applicants from the University of Wisconsin	For R01 renewals, reviewers assigned worse priority, approach, and significance scores to applications from women than men despite using standout adjectives (e.g., "outstanding," "excellent") and making	<ul style="list-style-type: none">Findings suggest that gender stereotypes may continue to create implicitly different referent standards for subjective interpretation of the research proposed by men and women	Kaatz, A, et al. <i>Acad Med</i> . 2016; 91(8):1080-8.

	references to ability in more critiques of women's applications	<ul style="list-style-type: none"> The R01s represented 103 study sections and funding from 21 NIH Institutes or Centers 	
National sample of R01s submitted 2010-2013 analyzed for predictors of funding success	R01s submitted by female investigators were significantly less likely to be funded than those submitted by male investigators	<ul style="list-style-type: none"> The study did not examine gender differences for R01 Type 2 renewals separately 	Eblen et al., PLoS ONE. 2016; 11(6): e0155060
National data of R01 Type 1 awards (2000-2006) modeled for gender and race/ethnicity-specific a gender differences	R01 award rates in adjusted models were: <ul style="list-style-type: none"> Not lower for women than men new or experienced investigators Lower for Black than White women MDs and PhDs Lower for Asian than White PhDs 	<ul style="list-style-type: none"> Women submitted fewer applications Black investigators were most disadvantaged for men and women Study did not examine R01 Type 2 renewals where the persistent gender gap is observed 	Ginther et al. Acad Med. 2016; 91(8):1098-1107
Combined qualitative and algorithmic text mining analysis of 241 critiques from 79 Summary Statements for 51 R01 renewals awarded to 45 investigators at the University of Wisconsin (some were the same critiques previously analyzed)	<ul style="list-style-type: none"> Male investigators were "leaders" and "pioneers" in their "fields," with "highly innovative" and "highly significant research;" female investigators had "expertise" and worked in "excellent" environments Applications from men received better priority, approach, and significance scores, which could not be accounted for by differences in productivity 	<ul style="list-style-type: none"> Subtle differences in words and descriptors in critiques of R01s from male and female applicants aligns with expected impact of gender stereotypes on judgment 	Magua, W, et al. J Women's Health. 2017; 26(5):560-570
Success rates of junior faculty receiving a new R01 at Harvard Medical School, 2008 and 2015	No gender difference	<ul style="list-style-type: none"> Did not examine R01 Type 2 renewals 	Warner et al., J Women's Health. 2017; ePub Volume 00, Number 00, 2017
NIH data on grant success rates from its public data RePORTER	New Type 1 R01s have equivalent success rates for men and women, but women's success rates for Type 2 R01 renewals are consistently lower than men's 1998-2016	<ul style="list-style-type: none"> The reasons for this persistent gender gap is unknown, but translates into 150-200 fewer women successfully renewing an R01 each year Implicit stereotype-based bias could be contributing to this gap 	U.S, DHHS, NIH Data Book https://report.nih.gov/NIHdatabook/Charts/Default.aspx?showm=Y&chartId=178&catId=15
*R01 includes R01-equivalent funding mechanisms			