



The Impact of Unconscious Bias on Women's Career Advancement

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Abstract

This paper reviews some of the extant research on unconscious (or implicit) bias, a term that refers to cognitive errors in the way humans process information about themselves and others based on stereotypic assumptions about social groups. Unconscious bias arises from the mere existence of group stereotypes and can lead to errors in judgment and decision-making that may unwittingly and unintentionally conflict with one's explicit and consciously held beliefs. We discuss how cultural stereotypes about men and women give rise to unconscious gender bias and how this bias systematically constrains opportunities for women's career advancement in organizations, particularly in taking up top leadership positions and in fields historically dominated by men such as the sciences, technology, engineering, mathematics, and medicine (STEMM). We conclude with a review of interventions that appear to be successful in mitigating the negative impact of unconscious gender bias on women in hiring and performance rewards. The discussion includes the description of one controlled study that approached unconscious gender bias as a remediable habit and was successful in helping faculty at one large university break the bias habit with improvements in department climate for all faculty.

Introduction

Unconscious bias is ubiquitous because it arises from the existence of cultural stereotypes about various social categories—including men and women. Stereotypes are a well-learned set of associations between some characteristic or behavior and any social category. Stereotypic associations are repeatedly activated and reinforced by experiences and the societal messages that bombard people on a daily basis throughout their lives. Although the content of these messages may vary from one country or culture to another, the process by which humans form stereotypic assumptions about groups of people is the same everywhere. Whenever groups of people share some common social characteristic or social identity (e.g., gender, race, country of origin, religion or occupation and so forth), stereotypic assumptions about that group are likely to emerge. For example, one can name common stereotypic assumptions about Germans, French, Japanese, or Americans (Spencer et al. 1999). Stereotypic assumptions may be accurate at a group level (e.g. men are taller than women) but may be inaccurate at an individual level (i.e., some women are taller than some men). The content of these stereotypes tends to be widely shared among members of any society, such that the prevailing cultural stereotypes are known even by those who do not consciously believe or endorse them (Devine 1989; Ghavami and Peplau 2013).

Group stereotypes can lead to two types of inter-group bias (Devine 1989). The most familiar type of bias is explicit bias that reflects a consciously endorsed personal belief about groups of people. This type of bias is typically measured in surveys. If one examines the responses to such surveys, one would conclude that prejudice within many countries has declined over the past half century. For example, in the past many people explicitly believed that women were incapable of being effective leaders, physicians, scholars, scientists, or engineers. Although women are still underrepresented in many of these fields, abounding evidence confirms that women can be quite effective in all these roles (Hill 2010; National Academy of Sciences, National Academy of Engineering, and Institute of Medicine 2007). Explicit prejudice is also demonstrated in the laws and practices that limit opportunities for some groups and favor others. For example, in the U.S. before the Civil Rights Act of 1964, Americans of African heritage were restricted from participating in many basic rights by law, and before the Education Amendment to this Act in 1972 (Title IX), many institutions of higher education had quotas restricting the number of women who could be admitted, regardless of their qualifications.

The second type of inter-group bias was first identified experimentally by Patricia Devine who examined race bias in the U.S. (Devine 1989). This type of unconscious (or implicit) bias is the unwitting and unintentional influence of stereotype-based preconceived assumptions about a group that occurs when judging an individual member of that group. The resulting cognitive distortion that occurs in processing information from an individual from a stereotyped group occurs even among those who explicitly reject the content of the stereotype. Stereotype-based assumptions—true or not—can override objective data in formulating judgments. For example, Monica Biernat and colleagues (1990) found that the general knowledge that men are taller than women led participants to judge women as shorter than men of identical height, even when

standing next to a common reference for height such as a desk or door frame (see also Biernat 2012). Another example of cognitive distortion of objective information can be seen in the increased number of women musicians selected for orchestras following the implementation of blinded auditions (Goldin 2000). When judges could observe the gender of the musician, they actually professed to hearing the music differently because of a preconceived assumption that women could not achieve the same tones or volume as men. A final, compelling example comes from research performed by Donald Rubin (1992). He found that undergraduate students heard more accented English when listening to a recorded lesson read by someone speaking Standard American English while viewing a picture of a teaching assistant of Asian heritage than when listening to the same recording while viewing a picture of a teaching assistant of European heritage. As these examples illustrate, stereotype-based assumptions can give rise to errors in cognitive processing of objective information. These distortions can subsequently influence judgment, decision-making, and behavior.

In summary, all people—including individuals who do not endorse a group stereotype at the conscious level and hold egalitarian beliefs, and aspire to act in accordance with meritocratic principles—are vulnerable to the influence of unconscious bias (Banaji 2013). This paper will focus on how unconscious bias conspires to limit access of women to careers in STEMM fields and to leadership positions in all fields. However, unconscious bias goes beyond just gender—individuals hold unconscious beliefs about a variety of social categories, including race and ethnicity, nationality, sexual orientation, body size and appearance, religion, and so forth.

Unconscious Gender Bias

Evidence for Unconscious Gender Bias

Even as recognition grows that gender is more complex than a male-female binary, stereotypic assumptions about men and women are widely shared and deeply pervasive in cultural norms. Traits and behaviors stereotypically associated with men include being aggressive, decisive, technical, strong, and logical while those stereotypically associated with women include being submissive, quiet, caring, relational, and nurturing (Bem 1974; Burgess and Borgida 1999). Stereotypic traits and behaviors more strongly associated with men are referred to as agentic and those more strongly associated with women are referred to as communal (Eagly 2002). Although there may be some variation in the content of these gender stereotypes, Virginia Schein and her colleagues (1996) found considerable similarities across cultures. In one study, a sample of 105 female and 211 male business students at a Japanese university expressed similar beliefs about gender role stereotypes and the characteristics of successful managers based on samples of individuals from China, England, Germany, and the U.S. (Schein, Mueller et al. 1989; Schein and Mueller 1992). She labeled her findings the think manager-think male phenomenon because the mental model of a leader overlapped to such a high degree with male gender stereotypes. A more recent meta-analysis confirmed that high status leadership roles in particular are stereotypically masculine (Koenig et al. 2011). Exposure to gender stereotypes occurs from birth and the information contained in these stereotypes is reinforced throughout life. These messages lay the foundation for unconscious gender bias that could shape the decisions of those in the workforce who determine who to admit, mentor, hire, promote, or fund and also influence potential scientists, engineers, entrepreneurs, and leaders, who must decide whether they fit in a specific career path or occupational role.

In 1968, Philip Goldberg conducted the first randomized experiment to demonstrate how unconscious gender bias, triggered by the assignment of a male (John T. McKay) or female (Joan T. McKay) gendered name as author of an essay, led evaluators to rate identical work differently based on whether they thought it was written by a man or a woman (Goldberg 1968). This experimental paradigm, subsequently termed the Goldberg design, has been used extensively to document the existence of gender bias in the evaluation of individual men and women or their work, and to test the effectiveness of interventions to reduce gender bias. Our research group performed a systematic review of all studies that used a Goldberg design to assess gender bias in experimental hiring settings (Isaac et al. 2009). Taken together, these studies document that both male and female evaluators, generally to the same degree, rate women applicants as being less competent, less hireable, and deserving of a lower salary than identically credentialed men, particularly when men and women are applying for high status or leadership positions. We found no change in the existence of gender bias over 30 years of research. In a more recent study using the Goldberg design, in addition to rating the female applicant for a laboratory manager position lower in these three areas than the identical male applicant, science faculty were also more willing to mentor the male applicant (Moss-Racusin et al. 2012). This finding is disturbing since mentorship is so critical to successful career advancement (Sambunjak 2006; Pfund et al. 2015).

The gender bias measured in laboratory studies is reflected in real world data. It was revealed that elite science laboratories are less likely to accept female graduate students (Sheltzer and Smith 2014); female graduate students are less likely to earn authorship on research papers despite greater hours spent conducting research (Feldon et al. 2017); women receive lower salaries than men for comparable work at all stages of careers in science (Wright et al. 2003; Jagsi et al. 2012; Jena, et al. 2016); women are less likely than their male peers to be promoted despite greater verbal praise (Biernat 2012) or comparable performance evaluations (Castilla 2012); and fewer than 5 percent of the largest companies in the U.S. are led by women (Zarya 2016). Just as experiments like those performed by Biernat and colleagues (1990) confirm that stereotype-based assumptions influence judgment even in the face of disconfirming data, these real world examples of gender bias occur in spite of evidence that collective intelligence of teams is greater when women are members of the team (Woolley 2010) and women are as effective as men in leadership roles and perhaps more likely to demonstrate a transformational (i.e., the most effective) leadership style (Eagly 1992; Bass 1999; Eagly 2003; Rosser 2003). Moreover, it was found that in a large U.S. study, patients cared for by female physicians had better clinical outcomes than those cared for by men after adjusting for numerous potential confounding variables (Tsugawa et al. 2017).

It is worth noting that gender bias can also disadvantage men who are less stereotypically masculine. For example, taller men have greater career success, higher incomes, and are more likely to attain managerial positions than shorter men (Judge and Cable 2004; Lindqvist 2011). Sabine Sczesny and colleagues (2006) completed a study in Germany and found that even among men, those whose facial features were deemed to be more stereotypically masculine in photographs were assumed to be more competent leaders. In other experimental studies, baby-faced men suffered discrimination similar to women in hiring for high status positions (Zebrowitz 1991), and egalitarian men or men who adopt communal behaviors suffered social penalties compared to those who adhered to more stereotypically masculine behaviors (Moss-Racusin et al. 2010; Rudman et al. 2013). Furthermore, only male applicants were disadvantaged in an experiment in which identical applications from a man or woman contained an employment gap (Smith 2005). In the absence of specific information, participants in this study made assumptions based on gender role stereotypes; they assumed that the employment gap for women was related to childbearing/rearing while the employment gap for men constituted a gender role violation because men are stereotypically assumed to be the family's breadwinner who needs to be continuously employed. In a similar vein, in both an experimental and field study, Ashleigh Shelby Rosette and colleagues (2015) found that male leaders were penalized for seeking help, presumably because this violated the male gender stereotype of being confident and independent.

One of the most widely used measures of unconscious bias for the past two decades has been the Implicit Association Test (IAT) developed by Anthony Greenwald and colleagues (1998; see also Nosek et al. 2007). A person taking an IAT is shown words or pictures on a computer screen and asked to categorize them by pressing keys on the keyboard. The person is instructed to do this as quickly as possible to bypass conscious cognitive processing and their reaction time is recorded. Sometimes pairs of words or pictures align with cultural stereotypes and sometimes they do not. Relevant to gender bias, the vast majority of both men and women who take an IAT in which they

are asked to sort American male and female gendered names with words associated with science (e.g., biochemistry) or the liberal arts (e.g., history), more quickly match male names with science words and female names with liberal arts words (Nosek et al. 2002), congruent with cultural and gender stereotypes. Similarly, the vast majority of people on other IATs more quickly match male gendered names with career roles (Nosek et al. 2002) and leadership words (Dasgupta 2004; Carnes, et al. 2015) and female names with domestic roles and supporter words, respectively. Although the unconscious bias measured with IATs may not reliably affect behavior (Carnes et al. 2015; Lai et al. 2016), it can be an important means of demonstrating the ubiquity of such bias to individuals who do not believe that they harbor stereotype-based bias about groups of people. The importance of providing this awareness is supported by experiments by Uhlmann and Cohen (2007) in which individuals who believe themselves to be objective demonstrated the most bias against a female applicant in evaluating male and female applicants with identical credentials (see also Uhlmann 2005). Greenwald and colleagues (2003) noted that the IAT could prove useful to detect bias within numerous settings including “personnel decisions, law enforcement decisions, criminal justice decisions, educational decisions, and health care decisions.”

How Gender Bias is Activated

Trivial amounts of information could bring forth unbidden the entire content of a stereotype. Once activated, the stereotype may serve as a perceptual filter, influencing the subsequent processing of information about an individual person, their work, or their performance. Although explicit prejudice against women is still relevant, much of the cognitive bias resulting from gender stereotype activation is unconscious. As Goldberg (1968) found, bias in evaluation can be triggered in the form of a name that is associated with one gender or another or anything else that is stereotypically more strongly linked with one gender. In the example of the blinded orchestra auditions, women found that they needed to remove their shoes during tryouts because even behind a curtain, the click of heels walking across the stage activated female gender stereotypes in the judges. Mazarin Banaji and colleagues (1993) found that exposing individuals to words that described stereotypical male or female traits led them to subsequently rate a man or woman, respectively, as having gender stereotypic characteristics. To accomplish this semantic priming, they had participants unscramble phrases that described either an aggressive behavior pre-tested as being stereotypically male (e.g., never backs down), a dependent behavior pre-tested as being stereotypically female (e.g., cannot manage alone), or a neutral behavior (e.g., reading a book) (Mazarin Banaji et al. 1993). In an ostensibly unrelated task, the participants were then given a short paragraph to read that described either a male (Donald) or a female (Donna) individual who displayed a series of behaviors. The participants were then asked to rate the individual on the target traits of aggressive or dependent, as well as other traits. They found that participants who were exposed to the aggressive prime rated Donald as more aggressive than when exposed to neutral primes. The same applied for Donna: she was rated as more dependent if they were exposed to the dependent primes compared to the neutral primes.

Such subtle and apparently trivial semantic priming may have real life consequences on women's opportunities for career advancement. For example, our research group (Carnes et al. 2005; Carnes 2006) pointed out that a contributor to the absence of women scientists among awardees

of the first round of the National Institutes of Health (NIH) Director's Pioneer Awards in 2004 may have been the large number of semantic primes in the solicitation and review criteria which would predict a more favorable review of male applicants. Specifically, there was a highly visible focus on funding scientists who would engage in high risk research and lead research that would result in technological breakthroughs; even the URL for the award contained the word, "risk" (www.highrisk.NIH.gov). Being willing to take risks was found to be a strongly male-gendered stereotype (Bem 1974; Konrad 2002). Exposing reviewers to these male-gendered semantic primes could have favored male applicants in the review process by triggering unconscious gender bias. Following the 2004 awards, NIH made substantial changes in the wording of the solicitation and review criteria in subsequent rounds, eliminating the focus on scientific risk-taking, and guiding reviewers to look at the work of the applicant rather than just the applicant. Of note, women have been represented among awardees in all subsequent rounds. We expressed similar concerns when NIH put forth the announcement for large center grants in clinical and translational research (Carnes and Bland 2007). We pointed out that a highly prestigious, large budget award that mandated a powerful leader of other leaders would almost certainly induce applicant institutions to put forth proposals led by men. Our prediction proved to be correct in that none of the initial 35 applications submitted was led by a woman. Our group also examined the wording in tenure criteria displayed on the public websites of the top 25 ranked medical schools in the United States (Marchant et al. 2007). Given the influence of semantic priming demonstrated experimentally by Banaji and colleagues (1993), we noted the potential importance of the greater number of stereotypically male-gendered words than female-gendered or neutral words in the tenure criteria in these schools. We also found that those schools that contained the word leader in their criteria compared to those that did not fell significantly below the median slope for increasing the proportion of women among the tenured faculty over a six-year period (Marchant et al. 2007).

Gender stereotypes can be activated by exposure to any information that is part of the stereotype. Many experimental examples demonstrate this. For example, Paul Davies and Claude Steele's (2002) research group found viewing television commercials that reinforced a female gender role significantly influenced the subsequent selection of career goals (Davies et al. 2002) or desire to assume a leader role in a group task (see also Davies et al. 2005). Peter Glick et al. (2005) found that clothing that was more feminine reduced the hiring selection of women for high status jobs. Sabine Sczesny et al. (2002) found that applicants wearing a scent (pre-tested to smell masculine) received the highest evaluations in evaluation for a leadership position compared to a feminine scent. Stout and Dasgupta (2011) examined the effect of gender-exclusive language in the application and hiring process. They manipulated gender pronouns (he/his vs. she/her) in job announcements and found that the use of male pronouns resulted in women being more likely to expect to be ostracized, less motivated to pursue a position, and a lower level of identification with the position. They also found that gender-exclusive language increased a woman's perception of sexism and lowered her sense of belonging. Men, however, did not have such negative reactions to the use of gender-exclusive language for a job description. Sapna Cheryan and colleagues (2009) showed how subtle gendered cues in the environment can activate unconscious gender bias and make women feel included or excluded from the traditionally male-dominated field of computer science by implicitly fostering or inhibiting ambient belonging. They had students, who were unaware of the purpose of the study, sit for one minute in a room

that contained either pre-tested items deemed typical for a male student (e.g., a Star Trek wall poster, video game boxes, and computer parts) or gender neutral items (e.g., a nature poster, art, or general interest books). Exposure to the male-typical items caused female students to be less interested in computer science than students exposed to the gender neutral items while having no effect on male students.

Lera Boroditsky and colleagues (2003) found that gender stereotypic assumptions can extend beyond the social world to include inanimate objects. For example, the word for key is masculine in German and feminine in Spanish. Speaking in English, native German speakers described keys with fairly agentic adjectives including hard, heavy, metal, and jagged while native Spanish speakers described keys as golden, intricate, little, and lovely. Conversely, the word for bridge is feminine in German and masculine in Spanish. In this case, German speakers described bridges with fairly communal adjectives including beautiful, elegant, fragile, and pretty, while Spanish speakers used adjectives such as big, dangerous, strong, and sturdy.

Because only women can be mothers, motherhood status alone triggers gender stereotypes that have been shown to disadvantage women in hiring evaluations for a high status position. Shelley Correll and colleagues (2007) have shown that when motherhood status is subtly signaled by noting on a resume membership in an organization for parents, with no other information about children, participants rated mothers as significantly less competent and having lower levels of work commitment than identical applicants who had no information in their resumes identifying their parental status. Participants also allowed fewer late days, required a higher qualifying examination score, recommended a lower salary, and predicted a lower likelihood of promotion for mothers compared to the non-mothers with the identical credentials. A childless woman was nearly twice as likely to be recommended for hire compared to a mother. In comparison, fathers were rated as significantly more committed, allowed more late days, and a higher salary than non-fathers. Correll et al. (2007) also completed an audit study in which resumes of mothers or non-mothers were sent in response to actual job openings. As in the experimental study, they found that childless women received twice as many callbacks from prospective employers as mothers. According to Hill et al. (2010) writing for the American Association of University Women, a single woman is more likely to be hired for a tenure-track position and promoted than a married woman. By contrast, in an experimental study, Madeline Heilman and Okimoto (2008) found that although motherhood status can work against a woman in many evaluative situations, once a woman has achieved a leadership position, information confirming her motherhood status may be beneficial. They conducted a Goldberg design study, which consisted of two identical applications (one male and one female) being evaluated for a position. They found that when no parental information was provided in the application, the identically credentialed man and woman were rated as equivalently competent, but the woman was rated as significantly less likeable. However, including a statement indicating that the manager had children resulted in equivalent ratings of likeability and desirability as a boss with no decrement in ratings of competence (Heilman and Okimoto 2007).

Prescriptive Nature of Gender Stereotypes

Gender stereotypes not only describe the general cultural assumptions and create behavioral norms about how men and women are (descriptive) or should be (prescriptive), they also establish implicit (and explicit) boundaries for how men and women should not behave (proscriptive). The resulting gender rules contribute to subtle (and sometimes not so subtle) gender-tracking of women and men toward different career outcomes. Our detailed examination of the written evaluations of medical students provides a window into the subtle yet consistent socialization of male students toward higher status, technical, agentic specialties (e.g., orthopedic surgery) and female students toward lower status, communal specialties (e.g., family medicine) (Isaac et al. 2011). This same kind of socialization may happen within a medical specialty with fewer women rising to full professor positions when controlling for potential confounding variables (Blumenthal et al. 2017; Carnes and Bairey Merz 2017).

One knows that unconscious bias is at play if switching genders in a thought experiment makes a role or behavior that may have appeared completely ordinary for one gender suddenly appear odd or incongruous. Although it may seem humorous when the thought experiment involves men walking in high heels (which usually invokes laughter) or wearing lipstick or a dress, it is not humorous when this same juxtaposition produces a lack of fit for women in top leadership positions or in male dominated fields such as engineering, computer science, or business. Both men and women pay social penalties for violating prescriptive gender norms, but men are not forced to violate gender norms simply by showing up for work and successfully doing their jobs (Heilman et al. 2004; Heilman 2012).

The assumptions about the traits and behaviors needed to be successful in certain occupations and in any top leadership role overlap with male stereotypes to a far greater extent than they do with female gender stereotypes (Koenig et al. 2011). Each time we teach our course on Women and Leadership in Medicine, Science, and Engineering (Isaac et al. 2012), we ask students on the first day to call out traits and behaviors that are part of a male stereotype. As noted above, all present are aware of the content of the stereotype and we always get words such as decisive, independent, strong, logical, competitive, and unemotional. Then we do the same for a female stereotype and get words such as nurturing, nice, caring, supportive, gentle, and emotional. We write these lists of words on the board. We then ask what traits and behaviors describe typical leaders. Each time, the words on this list overlap almost directly with the word list for male stereotypes. Eagly (2002) refers to this phenomenon as role congruity for male leaders (see also Eagly and Carli 2007). Women are not afforded the same role congruity for leadership as is afforded to men. This disadvantages women's career advancement in two ways. First, women suffer from competency bias for being women with the stereotypic assumption of lower ability than men in higher status and leadership roles. The second way women are disadvantaged is that if they do adopt stereotypically male behaviors, they will suffer in their evaluations and effectiveness because these same behaviors that are expected from men will incur social censure for violating prescriptive female gender norms when enacted by women (Eagly 1990; Heilman 2001; Heilman et al. 2004).

Madeline Heilman's research group demonstrated this clearly in a series of experiments

based on the Goldberg design (Heilman et al. 2004). They found that when performance was ambiguous (e.g., the leader was going to be coming up for the annual performance review), the assistant vice president with the female gendered name was rated as less competent, but more likeable, than the identical assistant vice president with a male gendered name. However, when performance was clear (the recent performance evaluation confirmed that the assistant vice president was performing in the top 5 percent of others in this position), the female leader was viewed as equivalently competent to her male counterpart, but was assumed to be less likeable and more interpersonally hostile. In a third study, they confirmed that likeability and competence independently predicted the willingness of the participants to confer institutional benefits. Laurie Rudman's research group (Rudman and Glick 2001) refers to the negative evaluations received by women who are competent in male roles as backlash against agentic women for breaking gender rules. Across several studies, her group (Rudman and Glick 2001) has shown, for example, that even at the risk of losing a game, participants will reject a competent woman as a partner if she brags about her skills, and that students evaluating applicants for a computer lab manager position placed greater value on social skills than on competence for female applicants, but not male (Phelan et al. 2008).

Heilman and Okimoto (2007) confirmed that the disadvantage faced by competent women in leadership roles is related to gender role violation in two ways. On the one hand, by succeeding in a male role, women leaders are violating the proscriptive gender rules of how women should not behave. On the other, they may be viewed as failing to adhere to the prescriptive gender rules of how women should behave and thus reproached for suffering from a communality deficit. In experiments with the Goldberg design, they examined the ratings of a male (James) or female (Andrea) applicant for a leadership position in a male-dominated field (vice president of financial affairs). Participants read introductions of the new vice president that included background information, descriptions of exemplary past work experiences and performance awards, and accounts of past supervisors and coworkers attesting to their outstanding effectiveness, competence, and aggressive achievements which were ascribed to doing what it took to succeed (Heilman and Okimoto 2007). Participants rated female and male leaders as equivalently competent and achievement-oriented, but rated Andrea as less likable, more interpersonally hostile, and less desirable as a boss than the identically credentialed James. The authors concluded that these negative assumptions resulted from the perception of a communality deficit because they were eliminated when the manipulation included statements about the communal aspects of the vice president's behavior at work such as being known to encourage cooperation and helpful behavior and having been commended for efforts to promote a positive community (Heilman and Okimoto 2007). Evaluations of the male vice president, James, were unaffected by the presence of communal statements. Furthermore, as in nearly all Goldberg design studies, both male and female participants demonstrated similar gender biases. As noted earlier, proof of motherhood status as confirmation of communality in another study by Heilman and Okimoto (2008), similarly led to more positive evaluations of a woman leader. Carol Isaac (2007) interviewed women deans about their leadership experiences and, working with our research group, interviewed faculty in departments with women chairs about their observations and perceptions of their chairs' leadership. In both situations, she found numerous examples that supported the experimental findings of Heilman's group and others: these top women leaders enacted effective leadership by exhibiting both agentic and communal behaviors. For example,

one faculty member noted that the chair wanted “each individual, whether it be faculty or staff or resident…to succeed and then, the logical consequence of that is that the department succeeds as a whole… I see her really caring about individuals… but I see no ego involved” (Isaac 2007, page 536).

In addition to the social penalties aimed at women who violate female gender norms, Rudman and Fairchild (2004) have studied the fear of backlash experienced by women themselves. This fear of backlash leads women to constrict their own behaviors, which can reinforce and perpetuate the existing gender rules. Girls are guided in the prescriptive and proscriptive restraints of gender stereotypes on their behavior from an early age with repeated admonishments to be modest and self-deprecating coupled with scolding for bragging or being bossy (Rudman and Fairchild 2004). Our research group documented fear of backlash expressed by female physicians in internal medicine residency (Bartels et al. 2008; Kolehmainen et al. 2014). In one study, we interviewed male and female residents about their experiences leading cardiopulmonary resuscitation events (codes) as part of their residency training (Kolehmainen et al. 2014). We qualitatively analyzed the text of semi-structured interviews from 25 internal medicine residencies at nine different training programs throughout the U.S. Both male and female residents described the ideal code leader in this urgent, time-sensitive, task-oriented setting in highly agentic, masculine terms (e.g., loud, deep voice, tall, authoritative presence, controlling the room, and so forth). No one explicitly perceived that the gender of the code leader mattered in terms of his or her effectiveness, but the need to behave in a counternormative way for women leading codes indicated a fear of backlash. For example, a number of female, but no male, residents described being concerned that they would appear “bossy” when giving orders during a code (Kolehmainen et al. 2014). Quotes from some of the female residents included: “I just felt kind of bad yelling at people”; “I just try my best to look authoritative… but it’s stressful”; “The most important thing is that when I ask for things they should not sound like orders;” and “You aren’t sure if people’s feelings are going to be hurt or if they are going to be mad about it” (Kolehmainen et al. 2014).

Gender Bias in Mathematically Intensive Fields

The cultural stereotypes that girls are less adept at mathematics than boys deserves special mention because it is particularly pernicious as the call for women to enter mathematically intensive fields grows (NSF 2007). This stereotype-based assumption persists in the face of considerable research to the contrary (Halpern et al. 2007; Lindberg et al. 2010). Despite having similar rates of interest in mathematics and science at a younger age, as girls and boys grow up a divide begins to emerge. According to the National Science Foundation in 1996, men are expected and demonstrated to be more interested in the field of mathematics than their female counterparts. The societal messages suggesting that boys belong in these technical fields—playing with Legos and Lincoln Logs growing up, and receiving feedback that they belong in this field—can reinforce to girls at a young age that they do not belong in this field. A study by Janet Hyde and colleagues (Hyde et al. 1990) found that starting in high school boys began to outperform girls in mathematics tests.

While boys and girls have an equal interest in mathematics in high school (NSF, 1996), a divide emerges during college where women are under-represented in math-intensive fields. A study by Nosek et al. (2002) examined implicit measures of “math attitude, math identity, math-gender stereotypes, and gender identity” in college students. They confirmed that students with the strongest female group identity had the most negative implicit attitudes toward mathematics. As girls grow up, they are socialized to believe that they cannot succeed in mathematics, and this stereotype can trigger implicit beliefs about their ability as they enter college and graduate school. The stereotypic assumption about women’s lower ability in mathematics is so tenacious that in an experimental study, Reuben et al. (2014) found that when participants were provided clear evidence of a woman’s competence in mathematics performance, they could only partially mitigate bias against selecting a woman instead of a man for a position requiring mathematics skills.

At the doctoral level, recent work from Andrei Cimpian’s research group (Leslie et al. 2015) has examined the relationship between the number of doctoral degrees in the U.S. awarded to women and the belief by those in the field and others that success in that field requires some innate brilliance. Relevant to unconscious gender bias, fields that valued giftedness over dedication had fewer women PhDs. Mathematics, physics, and computer science were some of the fields with the highest beliefs in the need for innate giftedness to succeed and had some of the fewest women receiving PhDs. This relationship could not be accounted for by scores on standardized tests, hours worked, or selectivity of the graduate program.

Stereotype Threat

In addition to influencing the way others evaluate an individual woman or her performance, unconscious gender bias based on cultural stereotypes can influence a woman’s own self-judgments and behaviors. As noted above, fear of backlash is one way internalized gender stereotypes can do so. Another way gender stereotypes can influence an individual woman’s behavior is through stereotype threat. This phenomenon was first described in an experiment that is now considered one of the modern classics in social psychology. In this experiment, male and female undergraduates at a top university in the U.S., all of whom saw themselves as strong mathematics students, were given a test composed of difficult items from the mathematics section of the Graduate Record Examination. Half of these students were told that the test showed gender differences; the other half was told that the test showed no gender differences. Remarkably, female students performed worse than their male counterparts when the test was described as showing gender differences, but performed as equally well as men when the test was described as showing no differences. Stereotype threat leads individuals to underperform relative to their abilities when they are members of a group that has negative performance as part of its group stereotype whenever they are reminded of their group identity (Steele and Aronson 1995; Steele 1997; Yedidia and Bickel 2001). An interesting manipulation of stereotype threat was conducted by Shih and colleagues (1999) in a group of female college students in the U.S. and Canada who were of Asian heritage. These students held two social identities with differing stereotypic content regarding mathematics performance—women with lower quantitative skills and Asians with greater quantitative skills. The researchers found that compared to a control

condition, the students performed worse on a mathematics test if they activated gender identity before the test by asking a few questions about their gender at the beginning of a mathematics test (e.g., whether they preferred a co-ed or single sex dormitory), but performed better than those in a control group when the questions activated their Asian identity (e.g., whether their parents or grandparents spoke any languages other than English).

Stereotype threat can lead to impaired performance by increasing stress (Carr et al. 2000), negative mood (e.g., anxiety, frustration, disappointment and sadness) (Logel et al. 2009), and monitoring of one's behavior, greater emotional regulation, as well as reduction in mental capacity, and decrease in motivation (Adams et al. 2006; Conrad et al. 2010). Individuals may be conscious of stress and anxiety under these circumstances, but often are not aware of its etiology, and thus are likely to attribute their anxiety to their own deficits rather than to the situation (Johns et al. 2005). This could lead women to self-select out of math intensive fields. Fortunately, simply informing women about the existence of stereotype threat appears to effectively inoculate against its negative impact on women's mathematics performance (Johns et al. 2005). Statements affirming identity safety are also effective. For example, in the previously mentioned study by Davies and colleagues (2005), women were less likely than men to select a leadership role in a group task under stereotype threat triggered by viewing women enacting female gender stereotypic behaviors in television commercials. However, when activation of the threat was followed by a statement confirming that both genders performed equally well in the leader and subordinate role in the group task, the gender difference in role selection vanished (Davies et al. 2005).

Given that lower performance in the realm of leadership is part of a female gender stereotype, it is not surprising that stereotype threat can be triggered when women are enacting leadership (Hoyt and Blascovich 2007; Hoyt et al. 2010). In collaboration with Diana Burgess and colleagues (2012), our research group described how the environment of academic medicine would be predicted to invoke stereotype threat in women leaders. These conditions are relevant to women's career advancement toward leadership in other fields as well because they are not unique to academic medicine. They include the frequent emphasis on leadership job requirements that are inconsistent with female gender stereotypes (e.g., strong, decisive leader who will take charge) rather than emphasizing neutral or stereotypically female stereotypes (e.g., collaborative, able to develop beneficial relationships within and beyond the organization); women's token minority and solo status in leadership which makes gender salient; reinforcement of gender hierarchy because supportive non-leadership roles are filled largely by women; and overt sexism, discrimination, and harassment. To help combat stereotype threat, we extrapolated from existing research and recommended teaching faculty members about stereotype threat, providing structured opportunities for female faculty members to share their experiences with each other, working to reduce sexual harassment and overt gender discrimination, training faculty in performance feedback that does not invoke negative stereotypes or sexism, increasing exposure to female leaders, avoiding framing criteria for awards or promotion in terms of stereotypically male gendered qualities, and encouraging leadership opportunities for female students to enhance their leadership self-efficacy. Leadership self-efficacy (i.e., self-perceived competency that one can lead) is important because research by Crystal Hoyt and Jim Blascovich (2007) find that leadership self-efficacy can buffer women from the damaging effects of stereotype threat (see

also Hoyt 2010). Leadership self-efficacy can develop by having experiences enacting leadership. Nancy Wayne and colleagues (2010) found that teachers can foster women's early experiences with leadership in their classes simply by intentionally stating that when students divide into work groups they should encourage someone who has not had leadership experience to lead the group task.

Bias to Opportunity in Leadership

Most of the extant research finds that unconscious gender bias works against women as they advance in careers, particularly in fields that have typically been occupied by men. However, as noted in Table 1, assumptions based on gender stereotypes could create preferential opportunities for women in some settings. Rosette and Tost (2010) point out that most of the research on how gender stereotypes and the resultant unconscious bias against women in leadership has examined women in middle management. They conducted two studies which found that the acknowledged gender bias that works against women as they rise in leadership may actually work in their favor when they occupy top leadership positions. This benefit derives from the assumptions that women had to be more competent and perform at a higher level than comparably credentialed men (i.e., a double standard) to gain access to such a high status position (Rosette and Tost (2010)). The first study presented participants with an article about a chief executive officer (CEO) and the recent performance of a fictional company. The gender of the CEO was signaled in a Goldberg design with a headshot photograph of a man or a woman matched for emotional expression and physical attractiveness. The company's success was indicated with a graphic display of earnings which showed either a steady increase or decline over a five-month period. Credit or blame for performance was manipulated to be either placed on the CEO or attributed to external market factors by having the article state that this was the conclusion of an industry analyst. Participants assessed the CEO on confidence, skillfulness, competitiveness, power, and capability (e.g., "I think the CEO is skillful") representing agentic characteristics; and on warmth, good nature, friendliness, consideration, caring, and understanding (e.g., "I think the CEO is friendly") representing communal characteristics (Rosette and Tost 2010). When the CEO was responsible for the success of the company, female CEOs were evaluated more favorably than male CEOs on both agentic and communal characteristics. No gender differences were found when the company failed or when the market was credited for its success. In the second study, participants read a brief performance summary of either a male or female middle-level manager or a top-level senior executive vice-president. The gender of the incumbent was signaled by name and the use of male or female gendered pronouns. In addition to the evaluation of agentic and communal traits, this study added an assessment of the leader's overall effectiveness (e.g., "I think that [Mr./Ms.] Jones is an exceptional leader") and questions to assess whether participants perceived the existence of a double standard of competence for men and women (e.g., "In general women have to work twice as hard to become a [top-level/mid-level] manager as men do") (Rosette and Tost 2010). Analyses of results indicated that women in top- but not middle-management positions were perceived to be significantly more effective than men in these positions and to be both more agentic and communal. This assumption was mediated by the perceived double standard. Statements by several faculty members we interviewed in departments with women chairs supported these experimental findings. They

expressed a sense of pride at having recruited such highly accomplished women with one noting that other departments in the country were “jealous” (Isaac 2010).

Table 1. The Same Unconscious Gender Bias that Usually Disadvantages Women Leaders Can Sometimes Turn Into Opportunity

Disadvantaging Bias	Potential Opportunity
<ul style="list-style-type: none"> The “think manager-think male” phenomenon creates “lack of fit”, role incongruity, and backlash for women leaders (Schein, Mueller et al. 1996; Rudman and Glick 2001; Eagly 2002; Heilman 2012). 	<ul style="list-style-type: none"> Women in top (but not middle) leadership may be viewed as more effective than men because of the general belief that they had to be better than comparable men to achieve this position (Rosette and Tost 2010). Women, but not men, in leadership positions can ask for help, a trait which is associated with good leadership, without being viewed as less competent leaders (Rosette, Mueller et al. 2015).
<ul style="list-style-type: none"> Women who self-promote or negotiate on behalf of themselves may incur penalties (Bowles 2007). 	<ul style="list-style-type: none"> Women may be more effective than men when negotiating on behalf of others (Amanatullah and Morris 2010).
<ul style="list-style-type: none"> Women who lead with an autocratic, directive style suffer in evaluation (Eagly 1992). 	<ul style="list-style-type: none"> A transformational leadership style combines agentic and communal behaviors and embodies many stereotypically female gender behaviors; e.g., caring about and mentoring one’s subordinates (Bass 1999; Eagly 2003). Women leaders who combine agentic and communal behaviors are the most effective (Heilman and Okimoto 2007).
<ul style="list-style-type: none"> Women’s contribution to a team effort may not be acknowledged on a team with men and women, while men’s contribution is acknowledged (Heilman and Haynes 2005). 	<ul style="list-style-type: none"> It is a good practice to acknowledge the contribution of all team members because specific acknowledgment of women’s expertise gains recognition of her contribution to a team effort (Heilman and Haynes 2005).
<ul style="list-style-type: none"> Women are socialized to have different communication styles more than men and these have been criticized (Heim and Golant 1993). 	<ul style="list-style-type: none"> Strategic display of positive emotion improved negotiation outcomes and women are more likely than men to exhibit these behaviors, which included being friendly and smiling (Kopelman, Rosette et al. 2006).
<ul style="list-style-type: none"> Women may be disadvantaged in negotiation because required negotiation behaviors violate female gender norms (Bowles 2007). 	<ul style="list-style-type: none"> External conferral of status with a title provided women, but not men, an advantage in negotiation (Amanatullah and Tinsley 2013).

Strategies to Mitigate Unconscious Gender Bias

A growing body of research has identified situations that facilitate the infiltration of unconscious bias into judgment and decision-making processes as well as interventions that can reduce the influence of unconscious gender bias. These interventions include institutional level changes in the working environment and in hiring and performance-reward practices and individual level strategies one can practice to break the gender bias habit.

To ensure that all individuals have equal opportunity to develop and use their talents and advance in their careers, the unintentional consequences of unconscious gender bias must be addressed. We discuss interventions that have been found to be effective in experimental studies in reducing gender bias in hiring and annual performance rewards. We conclude by reviewing a cluster randomized controlled study which approaches gender bias as a remediable habit with positive results.

Reducing the Influence of Unconscious Gender Bias in Hiring Practices

We conducted a systematic review of studies with randomized controlled designs that examined the impact of some interventions in an experimental hiring setting (Isaac et al. 2009). We evaluated 27 publications in detail (and some papers, including more than one study). The interventions fell into three categories: (1) varying the information provided to raters in the application (12 studies); (2) changing the behavior, scent, or appearance of the applicant (9 studies); and (3) altering the conditions under which raters assessed applicants (10 studies). From these and other more recent studies, we synthesized the following recommendations for evidence-based interventions that institutions can implement to reduce the likelihood that unconscious gender bias will inadvertently influence the evaluation of applicants:

- Design the application process to allow candidates to provide individuating evidence of job-relevant competency; ambiguity or partial information will encourage reliance on gender-based stereotypes to fill in absent information and disadvantage women.
- Visibly display evidence that men and women are equivalently successful in the position; this can be through statements such as “research confirms that men and women are equally successful at [position]”, pictures demonstrating men and women successfully performing the job (e.g., on wall posters, brochures, and websites), or through success in recruiting, retaining, and advancing more women to leadership positions.
- Work hard to ensure that women comprise at least 25 percent of an applicant pool; percentages

below this can trigger unconscious gender bias.

- Insist that raters commit to the value of specific credentials before seeing actual applicants; this prevents “reconstructing” the value of credentials to favor the male applicant.
- Rate specific qualifications before making summary judgments about applicant.
- Design equity directives and anti-bias training so that raters do not feel coerced to hire a woman; coercive practices can backfire leading to unqualified men being hired over qualified women.
- Do not ask about parenthood status in the application or interview questions.
- Encourage raters to spend adequate time and avoid undue distractions when evaluating a candidate; these encourage the cognitive habit of relying on gender stereotypes.
- Use structured rather than unstructured interviews; needing to think about what question to ask creates a cognitive distraction, encouraging reliance on gender stereotypes.
- Avoid gender-exclusive language (his/him) and do not use man-suffix in job titles (e.g. use chair or chairperson as opposed to chairman); this semantic priming leads evaluators to assume the position requires male-gendered traits.
- Substitute specific, descriptive language for abstract terms that are more stereotypically linked to men; for example, replace strong, charismatic leader with an individual who has led a team of at least [number] people and who has experience with...
- Implement training workshops for personnel decision-makers that include examples of common hiring biases and group problem-solving for overcoming such biases.
- Encourage raters to use an inclusion rather than an exclusion selection strategy in constructing a final list of applicants because this will consistently result in a shorter list that is less likely to be influenced by stereotypic assumptions.

Addressing Unconscious Gender Bias in Performance-Reward Practices

According to Hill (2016), there are practices organizations can establish to ensure women’s success within their field. Those in managerial roles must be held responsible for promoting women to leadership positions. The importance of the accumulation of advantage on a career should encourage institutions to examine annual performance-reward systems (Valian 1998). The success of Emilio Castilla’s (2015) work with a large service-sector company is noteworthy and could be extrapolated to other fields. In this company, women were receiving lower annual performance rewards than comparably performing men. This difference was eliminated by the

following two interventions. The first was the implementation of process accountability in the form of a committee that reviewed a manager's performance-reward decision and its justification for each employee. The committee had the ability to discuss the decision with the manager and to make adjustments. The second was outcome transparency in which all members of the organization can see the performance-reward decisions and rationale. All members of the organization received training in the new system and a staff person was hired to coordinate the effort. Gender bias in annual performance-rewards was completely eliminated.

Breaking the Gender Bias Habit

Our research group has found success in approaching unconscious gender bias as a potentially remediable habit. This neutral approach avoids blaming and shaming (who has not tried to break an unwanted habit) and allows us to mobilize effective strategies that foster health behavioral changes such as smoking cessation (Carnes et al. 2005; Carnes et al. 2012). As with any habit, breaking the bias habit is a multi-step process that requires more than good intentions. We developed an interactive workshop incorporating principles of behavioral change. The workshop has three modules. The first module presented unconscious bias as a habit of mind. The second module helped faculty become bias literate (Sevo 2008) so that they can identify and label instances of unconscious bias manifested in the workplace. The third module imparted five specific cognitive behavioral strategies grounded in research that could be practiced to overcome gender bias:

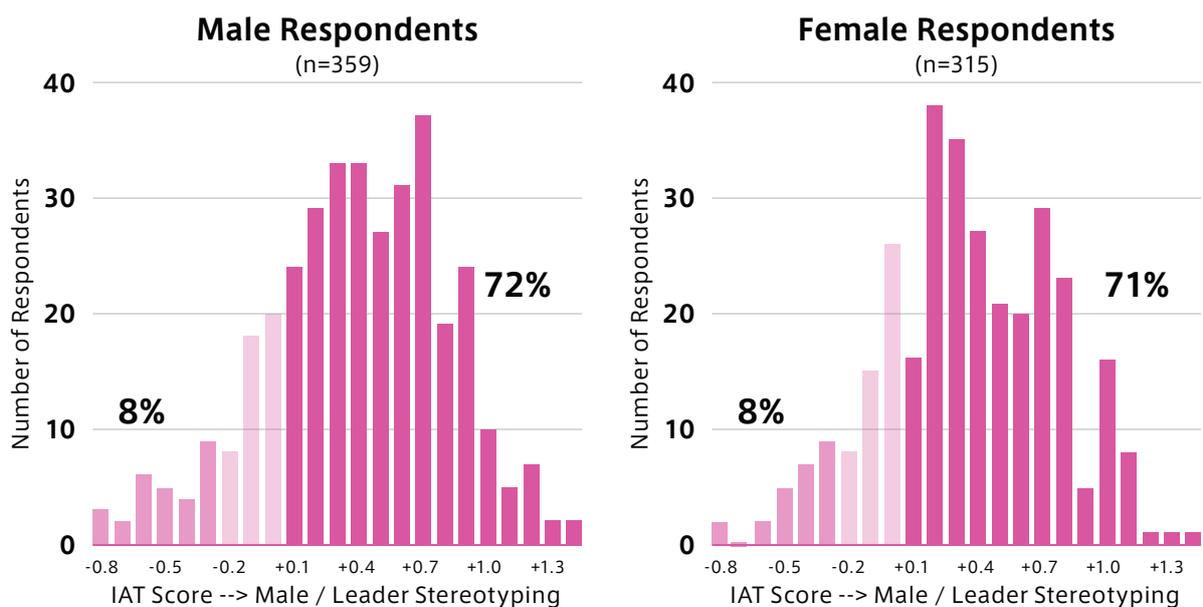
- Stereotype replacement (e.g., if girls are being portrayed as bad at mathematics, identify this as a gender stereotype and consciously challenge and replace it with accurate information);
- Positive counter-stereotype imaging (e.g., before evaluating job applicants for a position traditionally held by men, imagine in detail an effective woman leader—either one that is known or one in the abstract);
- Perspective taking (e.g., imagine in detail what it is like to be a woman and have your credentials questioned or to be viewed as unlikeable for being competent at your job);
- Individuation (e.g., gather specific information about an individual woman to prevent unconscious gender bias from leading to potentially inaccurate assumptions);
- Increasing opportunities for contact with counter-stereotypic exemplars (e.g., meet with senior women in your company or profession to discuss their ideas and vision).

We also presented two counterproductive strategies: stereotype suppression (i.e., attempting to be “gender blind”) and holding a strong belief in one's ability to make objective judgments. Both of these have been shown to enhance the influence of stereotype-based bias on judgment. To facilitate behavioral change, participants immediately applied content through paired discussions, audience response, case studies conducted as readers' theater, and a written commitment to action. As reminders to practice bias-reducing behaviors, participants received a folder containing

workshop materials, a bibliography, and a bookmark listing the six forms of bias discussed and the five bias habit-changing strategies.

In a study of over 2,000 faculty in science, medicine, and engineering departments at the University of Wisconsin-Madison, we tested the ability of this workshop to help faculty break the bias habit. Faculty in 46 randomly selected departments were allocated to the experimental group and received this intervention while 46 departments served as controls. Compared to faculty in control departments, three months following the workshop, faculty in the experimental departments were significantly more aware of their own personal bias, more motivated to engage in gender equity promoting activities, more confident that they could do so, and more likely to report engaging in gender equity promoting activities on a regular basis. In addition, on a separate survey, male and female faculty in the experimental departments reported a better working environment. Specifically, they were more likely to report that they felt they fit in their departments, that their research was valued, and that they were comfortable raising personal or family obligations even if they conflicted with departmental activities (Carnes et al. 2015). Two to three years after the intervention, the experimental departments showed a larger percentage of women among newly-hired faculty, suggesting that this intervention has a long lasting influence on attitudes and behaviors at the individual and departmental level (unpublished data). Over 600 faculty members took the gender-leadership Implicit Association Test (IAT) (Dasgupta 2004). Figure 1 shows that over 70 percent of male and female faculty demonstrated unconscious bias favoring male names and leadership words and female names and supporter words. Importantly, scores on this IAT were not affected by participation in the workshop. We interpret this to mean that ambient social information reinforces and maintains this bias, but that people can change their habitual behavior to promote gender equity even if they still show unconscious bias on an IAT test.

Figure 1. Gender and Leadership IAT Scores.



Source: Carnes et al. (unpublished paper)

Conclusion

Unconscious gender bias is ubiquitous. It is unlikely that such bias can be eliminated because cultural messages about men and women are everywhere and continually reinforce the stereotypic assumptions that give rise to unconscious bias. Unconscious gender bias is easily activated and applied even in those who aspire to be fair and egalitarian. However, research has identified effective strategies that can be deployed to prevent the unwanted and unintentional consequences of unconscious gender bias and its negative impact on women's career advancement in STEMM.

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