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The Effect of Gender on Attributions for Women's Anxiety and Doubt in a Science Narrative

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Abstract

Although the effect of biases and stereotype threat on women in science, technology, engineering, and math (STEM) fields is well documented, less is known about how men and women attribute an undergraduate woman's anxieties in a STEM class. We examined how undergraduate men and women perceive a woman facing emotional struggles in a physics class (Study 1: $N = 309$; Study 2: $N = 271$) and having her contributions ignored in an environmental science class (Study 3: $N = 344$) in three studies and an internal meta-analysis. Across the studies and meta-analysis, we found gender differences in reactions to the stories. Men were less likely than women to attribute the student's anxiety to bias-related factors, such as awareness of stereotypes or instructor treatment, and more likely than women to attribute the anxiety to the student's lack of preparation. Women were more likely to view the narratives as reflecting real-life experiences of women in STEM. The results indicate a lack of awareness, on the part of undergraduate men, of the difficulties faced by women in STEM classes. Based on the current findings, educators and researchers should consider the role that gender plays in how women's emotional responses in STEM contexts are interpreted. *Additional online materials for this article are available on* PWQ*'s website at http://journals.sagepub.com/doi/suppl/10.1177/0361684318754528*

Keywords

STEM, gender, stereotype threat, attitudes/attributions

Although there has been progress in increasing representation of women in science, technology, engineering, and math (STEM; Hill, Corbett, & St. Rose, 2010), women are still underrepresented and faced with systemic bias in these fields (Beasley & Fischer, 2012; Hill et al., 2010; Wasburn & Miller, 2006). Not only do women make up only 20–30% of physics, engineering, and computer science students (National Science Foundation, 2017), women are also passed over for STEM job opportunities that go to men with the same qualifications (Moss-Racusin, Dovidio, Brescoll, Graham, & Handelsman, 2012). A particularly pervasive issue for women in STEM is called stereotype threat, which is the anxiety about confirming an ingroup stereotype (Steele & Aronson, 1995). Women are often aware of the biases they face, and concern about confirming those biases can lead to worsened performance (Nguyen & Ryan, 2008; Shapiro & Williams, 2012) and departure from the STEM fields (Beasley & Fischer, 2012).

Despite the wealth of research on women in STEM and on stereotype threat (see Nguyen & Ryan, 2008, for a review), there is a critical gap in understanding how observers perceive and interpret the emotional responses that can result when faced with contexts or environments in which bias toward one's group is highly salient or likely to occur. Specifically, to our knowledge, researchers have not yet considered men and women's attributions for women's experience of anxiety or self-doubt in STEM classrooms, emotions that can be caused by stereotype threat (Osborne, 2001; Steele & Aronson, 1995).

Of course, not all women will experience anxiety or doubt in STEM contexts. However, due to forces such as stereotype threat, experiencing negative emotions, such as anxiety and doubt, is not an uncommon occurrence for women facing pervasive biases in STEM fields (Nguyen & Ryan, 2008). The goal of the present research was to examine how men and women's attributions of the causes of a character's

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emotions may differ when they read narratives describing a woman's experiences in a STEM class. Imagine that students in a physics class are forming groups for a research project. One of the students in the class, Jane, is among only a few women physics majors. However, the other students have noticed that sometimes Jane seems anxious about her performance. How might this observation affect the likelihood of choosing Jane for the research group? The answer may depend on the attributions the other students make for Jane's emotions. If they recognize that the presence of gender bias and possible stereotype threat may contribute to Jane's reactions, the students may maintain a positive view of Jane's potential. If, however, the students see Jane's anxiety as a signal that she may not have the ability to succeed in the field, they may be less likely to select Jane to be in their research group.

Gender Biases in STEM

The prevalence and effect of gender biases in STEM fields and learning environments are a major concern for the advancement of science. Men greatly outnumber women in STEM fields at the baccalaureate level, and more so at the graduate level (National Science Foundation, 2017), particularly in fields that are traditionally considered more masculine (e.g., physics, computer science, and engineering; Nosek, Banaji, & Greenwald, 2002). Although many explanations have been offered for the underrepresentation of women in STEM, a great deal of evidence points to the role of bias in women's attrition from STEM fields (National Research Council, 2007). For example, researchers in the 1990s examined the influence of applicant gender on evaluations of a job candidate for an academic position and found that both men and women reported being less likely to hire the woman candidate with the same curriculum vitae (Steinpreis, Anders, & Ritzke, 1999). Over a decade later, faculty are still more likely to hire men over women applicants for an academic job in STEM fields, such as lab manager positions (Moss-Racusin et al., 2012). Also, both men and women are more likely to hire a man than a woman to complete math-related tasks, even if the potential hires have similar prior performance (Reuben, Sapienza, Zingales, & Greenwald, 2014).

The effect of stereotypes and biases on women in STEM is widely acknowledged, and there has been a recent call for individuals to become more aware of how biases affect women (i.e., to increase gender bias literacy; Carnes et al., 2012; Sevo & Chubin, 2008). An important first step to creating interventions geared toward the increased representation of women in STEM is to ensure that both men and women are aware of the existence and effect of biases on female students (Carnes et al., 2012). Interventions to increase gender bias literacy have taken a range of forms from narrative videos presented online to an adult population (Pietri et al., 2017) to classes about feminism and equality for undergraduate students (Case, 2007); and such programs have shown efficacy in increasing awareness. Despite the wealth of research on the effect of biases on women in STEM, there has been little research on how gender biases affect perceptions of women's emotions in STEM contexts. For instance, in the narrative video intervention that increased awareness of bias, the authors examined the effect of the videos on perceptions of outcomes (e.g., "women in science fields often face negative reactions for being assertive"; Pietri et al., 2017, p. 181), not attributions for emotional states (e.g., interpreting why women may experience anxiety).

Stereotypic Attribution Bias and Intergroup Attribution Bias

In foundational work on gender and attribution, researchers focused on how individuals perceive the successes and failures of men and women. Results from studies in the 1970s indicated that individuals were likely to attribute men's successes to skill and women's successes to luck, whereas the reverse was true for failures (Deaux & Emswiller, 1974; Deaux, White, & Farris, 1975; Etaugh & Brown, 1975; Feather & Simon, 1975). When women failed in a domain that was more stereotypically masculine (e.g., medicine), individuals were especially likely to attribute that failure to a lack of skills or ability (rather than an external, situational cause). However, 20 years later, the gender pattern for attributions seemed to disappear, with individuals no longer perceiving women's failures in a male-oriented career as stemming from their lack of skill (Taylor et al., 1993).

The seeming reversal of attribution biases has not extended to STEM fields: In samples of undergraduate STEM students, men's failures in STEM fields have been attributed to external factors (e.g., he was sick that day), whereas women's failures in STEM fields have been attributed to internal reasons (e.g., she was not smart enough; LaCosse, Sekaquaptewa, & Bennett, 2016). This STEM stereotypic attribution bias is particularly prevalent when the climate in STEM is perceived as unwelcoming toward women (LaCosse et al., 2016). Furthermore, both men and women exhibit this bias (LaCosse et al., 2016; Sekaquaptewa, Espinoza, Thompson, Vargas, & von Hippel, 2003). STEM stereotypic attribution bias occurs because of expectations regarding men and women in STEM. Results from recent studies of grades and scores in STEM do not show gender differences in achievement (e.g., Hyde, Lindberg, Linn, Ellis, & Williams, 2008; Margolis & Fisher, 2002). Nonetheless, men are stereotypically seen as good at math and science, whereas women are not (Carli, Alawa, Lee, Zhao, & Kim, 2016). Therefore, when men fail in STEM, it is a stereotype-inconsistent behavior, but when women fail, it is stereotype-consistent (LaCosse et al., 2016; Sekaquaptewa et al., 2003). When individuals are trying to attribute behaviors to causes, an inconsistent behavior is likely to trigger a search for an explanation and external attributions will come to mind. If the behavior, however, is consistent, then individuals may engage in the fundamental attribution error (Ross, 1977): attributing the behavior to something about that person (i.e., an internal attribution; Lacosse et al., 2016; Sekaquaptewa et al., 2003).

Feelings of doubt or anxiety in STEM can arise from two sources. STEM courses often present challenging material, so individuals (regardless of gender) may experience anxiety due to the difficulty of the tasks. However, women may also experience additional anxiety due to fear of confirming a negative stereotype (Cadinu, Maass, Rosabianca, & Kiesner, 2005; Osborne, 2001; Spencer, Steele, & Quinn, 1999). As women attempt to avoid confirming a negative stereotype, they may engage in hypervigilant and ruminative behavior in which they exhibit heightened awareness of their own anxiety (Schmader, Johns, & Forbes, 2008). Being more aware of one's anxiety can, in turn, induce more anxiety and serve as a cue that one is not succeeding (Schmader et al., 2008). In other words, stereotype threat can, at times, lead to a feedback loop that increases anxiety. A failure to recognize these bias-related sources of emotions can have important consequences for observers' judgments. Much like behavioral attributions, attributions about the source of women's emotional reactions in STEM contexts may have a variety of outcomes, including judgments about a woman's potential future success in the field. This is a particularly salient issue with regard to gender because an additional stereotype of women is that they are "too emotional" (Barrett & Bliss-Moreau, 2009; Fabes & Martin, 1991; Hess et al., 2000; Kelly & Hutson-Comeaux, 2000; Timmers, Fischer, & Manstead, 2003) to succeed in scientific fields.

Although both men and women exhibit stereotypic attribution bias, intergroup attribution bias may be involved when men and women are making judgments about women in science, specifically. According to intergroup attribution bias, also called ultimate attribution error (Pettigrew, 1979), an individual is more likely to make dispositional attributions for ingroup members' positive behaviors and situational attributions for ingroup members' negative behaviors, whereas an individual is more likely to make dispositional attributions for outgroup members' negative behaviors and situational attributions for outgroup members' positive behaviors (Hewstone, 1990; Pettigrew, 1979). Thus, it is possible that when men think about women (an outgroup) and their negative emotional reactions in a STEM environment, they might be more likely to attribute those emotions to dispositional or internal factors (e.g., not having good coping skills, not preparing for the class). Women on the other hand may engage in more situational attributions when thinking about women in science and attribute negative emotions to situational factors (e.g., the way the woman was treated by others).

To our knowledge, researchers examining gender and attributions have not examined how bias affects emotional attributions. Instead, researchers have focused on attributions for behaviors. It is important to consider how men and women will emotionally understand and interpret a woman's STEM-related anxiety or doubt. If women are stereotypically seen as unable to excel in math due to their internal characteristics (e.g., not being intelligent enough), then their emotional reactions to struggling in a STEM class are likely to be attributed to those internal characteristics. We also sought in the current study to address the open question of how women and men might differ in their perceptions of women in STEM.

Present Research

In three studies, we examined whether men and women differ in the attributions they make for an undergraduate woman's anxiety and doubt in a STEM class. Study 1 was an exploratory study in which participants were presented with a story about a student who encountered ambiguous bias. After reading the story, the participants were asked to make judgments about the cause of the student character's anxieties. Study 2 was a replication of Study 1 using the same story. Study 3 was a conceptual replication that used a different story that presented different instances of bias. Finally, we conducted an internal meta-analysis to examine the pattern across the three studies.

Study 1

In Study 1, we examined whether men and women participants were equally likely to attribute anxiety to bias-related factors, such as awareness of stereotypes and instructor treatment, and student-related factors, such as a lack of preparation or an inability to cope.

Method

Participants

Four hundred thirty-three participants were recruited through a Communication Department participant pool at a university in the Northeast and given course credit for participating. This participant pool was chosen because the course meets general education course requirements and is taken by students with a range of majors. Participants who failed either of the two attention checks ($n = 117$) or did not report gender ($n = 7$) were excluded, leaving a final sample of 309 participants (138 women; $M_{\text{age}} = 19.75$, $SD_{\text{age}} = 1.68$; 7.1% African American, 25.2% Asian or Asian American, 2.3% Hispanic/Latino, 0.3% Native American, 58.9% Caucasian, 5.9% other or multiracial, and 0.3% did not report ethnicity). Participants were divided across undergraduate year as follows: 20.1% first-year students, 36.2% second-year students, 31.7% third-year students, 11.3% fourth-year students, and 0.6% other. On average, participants had taken 6.05 STEM courses ($SD = 8.20$, range: 0–50). Students were asked the following question: "How many undergraduate science, technology, engineering, and math courses have you taken (including courses in which you are currently enrolled)?" However, given the high numbers at the end of the range for this question in Studies 1, 2, and 3, it seems likely that some students provided their number of credits instead of courses or included Advanced Placement courses taken in high school.

Due to the high number of participants excluded through the manipulation check, we examined whether there were differences in gender distribution or number of STEM courses taken between the included and excluded participants. The participants who were excluded did not differ from included participants on the number of STEM courses taken, $t(389) = 0.96$, $p = .337$. However, there was a gender distribution difference between included and excluded participants such that there were 55% men in the included group and 72% men in the excluded group, $\chi^2(1) = 9.56$, $p = .002$. We discuss this limitation in the Discussion section.

Procedure

Participants read a narrative online as part of a larger study on narratives (see Kaufman, Freedman, Fitzgerald, Green, & Flanagan, 2018). As part of that larger study, participants were randomly assigned to a story that was described as fiction or autobiography and was told in the first, second, or third person. These two variables (story genre and narrative voice) did not interact with gender (all *p*s > .25), and therefore, we do not discuss them further in the present study. The larger study was divided into two research projects: the present research on gender and emotional attributions and the other a test of how narrative voice and genre affect the efficacy of a narrative to convey stereotype threat (Kaufman et al., 2017).

The narrative (approximately 2,600 words) that students in the current study read described a student named Trisha who was struggling in her college physics class (see Online Appendix A at http://journals.sagepub.com/doi/suppl/10.1177/0361684318754528). In this narrative, there are ambiguous incidents in which it is unclear whether or not the physics instructor is treating Trisha different from the other students because she is a woman. For example, he offers her and the only other women students in the class extra help after they do not receive As on an exam; when handing back an assignment on which Trisha performed well, he asks whether Trisha did all the calculations herself. Trisha's anxiety is described throughout the narrative:

> Trisha thought about her courses and realized she was probably a little more nervous about her physics lab than her other classes.
>
> Physics lab was going okay—the calculus they'd used in the first month of lab involved the kinds of equations and techniques she was pretty familiar with from studying for the AP test. Now that they were getting into more advanced topics, though, she was starting to feel the pressure.
>
> A week later, Professor Donaldson handed Trisha's midterm exam back to her at the end of lab. She folded it nervously and put it away, resolving to look at it later. There was nothing more awkward than getting excited—or upset—about a nerves-inducing grade in front of other people.

Measures

After reading the narrative, participants completed a set of questions about their perceptions of the narrative. We asked six questions about the attributions for Trisha's anxiety about her physics class. Participants answered each question on a scale from 1 (*not at all*) to 9 (*very much*). The questions were: "To what extent do you believe that Trisha's anxiety during the test was caused by: (1) her awareness of negative stereotypes about women's ability to excel in science, (2) the way she was treated by her instructor throughout the term, (3) her level of ability to excel in the topics covered by the class, (4) her lack of adequate preparation for the exam, (5) her perceived lack of support from other students in the class, and (6) her inability to cope with the stress of a challenging class?" Participants were also asked to what extent: "Trisha's experience in her class, as described in the story, is similar to the experience that many female students in undergraduate science classes have," 2) "The instructor in the story may have been affected by unconscious bias (i.e., bias that he may not have been aware of) against female students in his class," and 3) "The instructor in the story may have been affected by conscious bias (i.e., bias that he was aware of) against female students in his class." All three questions were answered on a scale from 1 (*not at all*) to 9 (*an extreme amount*).

Participants also completed a set of measures for the purpose of the larger study, including level of transportation (Green & Brock, 2000), experience-taking (Kaufman & Libby, 2012), and perceptions of Trisha and the instructor.

Results and Discussion

To examine how gender affects attributions, we conducted multivariate analysis of variance (MANOVA) with gender as the between-subjects variable and the six attributions as the dependent variables (awareness of negative stereotypes, instructor treatment, ability, lack of preparation, lack of support, and inability to cope). We found a statistically significant difference in attributions based on participant gender: $F(6, 301) = 2.62$, $p = .017$; Wilks's $\Lambda = .95$, $d = .46$. As shown in Table 1, men (compared to women) were significantly less likely to attribute Trisha's anxiety to the instructor's treatment and Trisha's awareness of stereotypes. There were no significant differences for the other attributions (Trisha's ability, Trisha's lack of preparation, perceived lack of support, and inability to cope; see Table 1).

We implemented a Bonferroni correction for the three non-attribution questions (see Table 2), resulting in a corrected α level of $p = .017$. Men were significantly less likely than women to believe that Trisha's experiences were similar to those of other women in college science classes (see Table 2). There were no gender differences in perceptions of how much the instructor was affected by conscious or unconscious biases (see Table 2).

Table 1. Attributions for Anxiety across Studies 1–3 and the Meta-Analysis.

Anxiety Attributions	Men M (SD)	Women M (SD)	Gender Difference
Awareness of stereotypes			
Study 1	5.60 (2.11)	6.17 (1.98)	*$F(1, 306) = 5.97, p = .015, d = -.28$
Study 2	5.63 (2.11)	6.34 (1.83)	*$F(1, 268) = 8.79, p = .003, d = -.36$
Study 3	4.75 (2.13)	5.41 (2.03)	*$F(1, 341) = 8.10, p = .005, d = -.31$
Meta-analysis	*$d = -.33$, $SE = 0.07$, $p < .001$, 95% CI [−0.46, −0.20]		
Instructor's treatment			
Study 1	6.45 (1.77)	6.96 (1.69)	*$F(1, 306) = 6.62, p = .011, d = -.29$
Study 2	6.49 (1.82)	6.82 (1.70)	$F(1, 268) = 2.28, p = .132, d = -.18$
Study 3	5.76 (1.75)	6.33 (1.75)	*$F(1, 341) = 8.81, p = .003, d = -.32$
Meta-analysis	*$d = -.27$, $SE = 0.07$, $p < .001$, 95% CI [−0.40, −0.14]		
Ability			
Study 1	5.48 (1.82)	5.46 (1.94)	$F(1, 306) = .003, p = .953, d = .00$
Study 2	5.03 (2.13)	4.24 (1.96)	*$F(1, 268) = 10.19, p = .002, d = .39$
Study 3	5.05 (1.77)	5.06 (1.98)	$F(1, 341) = 0.003, p = .957, d = .00$
Meta-analysis	$d = .12$, $SE = 0.13$, $p = .34$, 95% CI [−0.13, 0.37]		
Lack of preparation			
Study 1	3.98 (2.05)	3.83 (2.27)	$F(1, 306) = .40, p = .527, d = .06$
Study 2	4.14 (2.17)	3.26 (1.84)	*$F(1, 268) = 12.90, p < .001, d = .44$
Study 3	5.01 (1.93)	4.31 (2.02)	*$F(1, 341) = 10.34, p = .001, d = .35$
Meta-analysis	*$d = .28$, $SE = 0.11$, $p = .01$, 95% CI [0.06, 0.50]		
Perceived lack of support			
Study 1	4.88 (1.95)	4.58 (2.21)	$F(1, 306) = 1.57, p = .211, d = .14$
Study 2	4.72 (1.96)	4.57 (1.90)	$F(1, 268) = .45, p = .503, d = .09$
Study 3	5.39 (1.73)	5.28 (1.70)	$F(1, 341) = .32, p = .571, d = .06$
Meta-analysis	$d = .08$, $SE = 0.07$, $p = .22$, 95% CI [−0.05, 0.21]		
Inability to cope			
Study 1	6.03 (1.85)	6.38 (1.92)	$F(1, 306) = 2.60, p = .108, d = -.18$
Study 2	5.75 (1.80)	5.01 (2.05)	*$F(1, 268) = 9.91, p = .002, d = .39$
Study 3	5.37 (1.70)	4.98 (1.92)	$F(1, 341) = 3.84, p = .051, d = .21$
Meta-analysis	$d = .14$, $SE = 0.17$, $p = .41$, 95% CI [−0.20, 0.48]		

*$p < .05$.

Table 2. Gender Differences in How Similar the Narrative Was to Real Life and the Effect of Biases on the Instructor Across Studies 1–3 and the Meta-Analysis.

Perceptions of Bias and Similarity	Men M (SD)	Women M (SD)	Gender Difference
Experiences similar			
Study 1	5.32 (1.57)	6.16 (1.51)	*$t(298) = 4.71, p < .001, d = -.55$
Study 2	5.22 (1.59)	5.82 (1.63)	*$t(266) = 3.07, p = .002, d = -.38$
Study 3	5.66 (1.56)	6.21 (1.59)	*$t(341) = 3.17, p = .002, d = -.34$
Meta-analysis	*$d = -.42$, $SE = 0.07$, $p < .001$, 95% CI [−0.55, −0.29]		
Unconscious bias			
Study 1	5.67 (1.62)	5.79 (1.71)	$t(307) = .62, p = .54, d = -.07$
Study 2	5.59 (1.74)	6.18 (1.89)	*$t(268) = 2.66, p = .008, d = -.32$
Study 3	5.60 (1.66)	6.36 (1.71)	*$t(341) = 4.09, p < .001, d = -.44$
Meta-analysis	*$d = -.28$, $SE = 0.11$, $p = .013$, 95% CI [−0.51, −0.06]		
Conscious bias			
Study 1	5.06 (1.74)	5.17 (1.86)	$t(307) = .50, p = .62, d = -.06$
Study 2	4.60 (2.03)	4.81 (2.09)	$t(268) = .85, p = .40, d = -.10$
Study 3	4.92 (1.71)	5.52 (1.43)	*$t(341) = 3.39, p = .001, d = -.37$
Meta-analysis	$d = -.18$, $SE = 0.10$, $p = .069$, 95% CI [−0.38, 0.01]		

*$p < .05$.

Study 1 provides evidence that men and women differ in some of their attributions for a woman student's anxiety in a physics class. Specifically, women were more likely than men to attribute the anxiety to bias-related factors such as awareness of stereotypes and the instructor's treatment. Furthermore, women were more likely than men to view the narrative as accurately reflecting women's experiences in STEM classes. Men and women did not differ in their perceptions of how much ability, lack of preparation, perceived lack of support, and inability to cope were responsible for Trisha's anxiety. In addition, men and women did not differ in how much they saw the instructor being affected by conscious or unconscious biases.

Study 2

Study 2 was a replication study in which the same procedure from Study 1 was used to further test the effect of gender on attributing anxiety to stereotype awareness and instructor treatment. Based on the results from Study 1, it was hypothesized that men would be less likely to attribute Trisha's anxiety to instructor treatment and awareness of negative stereotypes than women and that women would view the narrative as more similar to what women actually experience than men.

Method

Participants

Four hundred two participants were recruited from two universities in the Northeast and were given either course credit or a US$5 gift card in compensation. Participants were recruited both from a Communication Department participant pool and from a list of STEM majors in order to make sure that STEM majors were well represented in this replication. Participants who failed either of the two attention checks (n = 110), reported "other" for gender (n = 3), or did not report gender (n = 18) were excluded, leaving a final sample of 271 participants (136 women; $M_{\text{age}} = 20.35$, $SD_{\text{age}} = 1.37$; 5.5% African American, 23.6% Asian or Asian American, 5.2% Hispanic/Latino, 1.1% Native American, 55.7% Caucasian, 7.7% other or multiracial, and 1.1% did not report their ethnicity). In terms of class year, 10.7% of participants were first-year undergraduate students, 25.1% were second-year students, 33.2% were third-year students, and 31.0% were fourth-year students. On average, participants had taken 10.08 STEM courses ($SD = 8.53$, range: 0–65). As in Study 1, we examined whether there were differences in gender distribution or number of STEM courses taken between the included and excluded participants. Included participants had taken more STEM classes ($M = 10.08$, $SD = 8.53$) than excluded participants, $M = 8.07$, $SD = 8.26$, $t(371) = 2.07$, $p = .039$, 95% confidence interval [CI] = [0.10, 3.93]. There was also a gender distribution difference between included and excluded participants such that there were more men in the excluded group (63%) than there were in the included group, 50%, $\chi^2(1) = 5.24$, $p = .024$.

Procedure

Participants read the same Trisha narrative online as the one used in Study 1, with minor revisions to make the story shorter and to allow the participants to interact more with the story by clicking what should happen next. Irrelevant passages were cut. For example, a brief passage about a turtle in the Trisha story in Study 1 was cut from the narrative in Study 2. Furthermore, in Study 2, participants were also randomly assigned to one of two agency conditions: In the first condition, their "choices" of what to do next seemed to matter (i.e., their selections were referenced later), and in the second condition, their selections were not later referenced. The two conditions were designed to be options that would have no effect on the story, but the high agency condition was designed to make participants think their choices affected the story and the low agency condition was designed to make participants think their choices did not affect the story. For example, one section of the high agency condition was: "I ran directly into someone rushing off in another direction. There were papers everywhere. I looked around at the mess that I had caused and back at my phone to check the time, unsure about how to proceed." The two choices offered were (1) "I'm so sorry. Let me help you clean up." or (2) "I'm so sorry for the mess, but I've got to run." If participants chose Choice 1 they then saw: "Even though I stopped to help, I made it with one minute to spare, but everyone else was already sitting with their notebooks out. The door slammed behind me." If they chose Choice 2, they saw: "Because I rushed to class, I made it with one minute to spare, but everyone else was already sitting with their notebooks out. The door slammed behind me." However, this manipulation failed to increase agency ($p = .99$) and is therefore not included in analyses. Participants completed the same measures from Studies 1 in Study 2.

Results and Discussion

As in Study 1, using a MANOVA, we found a statistically significant difference in attributions based on participant gender: $F(6, 263) = 4.54$, $p < .001$; Wilks's $\Lambda = .91$, $d = .64$. Replicating the results of Study 1, men were less likely to attribute Trisha's anxiety to awareness of stereotypes (see Table 1). However, unlike Study 1, there was no significant effect of gender on attributing Trisha's anxiety to the instructor's treatment. Furthermore, in Study 2, men were more likely to attribute Trisha's anxiety to her lack of ability, her lack of preparation, and her inability to cope than women (see Table 1). There was no gender difference in attributing her anxiety to a perceived lack of support.

A Bonferroni correction for the three non-attribution questions was implemented resulting in a corrected α level of $p = .017$. Men were less likely to believe that Trisha's experiences were similar to those of other women in college science classes than women (see Table 2). Unlike in Study 1, men were less likely ($M = 5.59$, $SD = 1.74$) than women ($M = 6.18$, $SD = 1.88$) to believe that the instructor was affected by unconscious biases (see Table 2). There were no gender differences for perceptions of the instructor's conscious biases.

The results of Study 2 partially replicated the findings from Study 1. In both studies, men were less likely than women to view Trisha's anxiety as stemming from bias-related factors, and there was no gender difference in attributing Trisha's anxiety to a perceived lack of support. In contrast to Study 1, in which we found no gender differences in student-related factors, in Study 2, women were less likely than men to view Trisha's anxiety as stemming from her lack of ability, lack of preparation, or inability to cope. In addition, in Study 2, women were more likely than men to believe that the instructor was affected by unconscious bias. As in Study 1, there was no gender difference in perceptions of conscious bias affecting the instructor.

The main design difference between Studies 1 and 2 was that the narrative in Study 2 had a more interactive element. That is, instead of merely clicking "next" after each passage of text, participants had to make a choice, as noted above. However, the choices made did not alter the outcome of the story. Despite the more interactive nature of Study 2, there was still a high exclusion rate based on the attention checks.

Study 3

In Study 3, we created a new narrative for a conceptual replication of the first two studies. The new narrative featured a student from an ostensibly different ethnicity ("Rosalia"), a different biased experience, a different emotion (doubt), and a different STEM field (environmental science) that is not be as male-dominated as physics (National Science Foundation, 2017). In the new narrative, instead of struggling with performance in the class, the woman student struggles to receive credit for her ideas. By using a new narrative with a different difficulty encountered by women in STEM, we were able to test whether gender differences in bias-related attributions for anxiety extended beyond a student concerned about performing poorly. In addition, a measure of attitudes toward women in science was added to Study 3 to conduct an exploratory analysis of whether attitudes toward women in science mediate the relation between gender and attributions. Specifically, do women feel more positively toward women in science and does that partially explain why they are more likely to attribute negative emotions in STEM to bias-related causes?

Method

Participants

Four hundred fifty-nine participants were recruited through a Communication Department participant pool at a university in the Northeast and were given course credit for participating. Participants who failed either of two attention checks ($n = 10$), reported "other" for gender ($n = 7$), or did not report gender were excluded ($n = 98$), leaving a final sample of 344 participants (135 women; $M_{\text{age}} = 20.16$, $SD_{\text{age}} = 2.64$; 10.2% African American, 26.5% Asian or Asian American, 6.8% Hispanic/Latino, 0.3% Native American, 48.8% Caucasian, 6.8% other or multiracial, and 0.6% did not report their ethnicity). In terms of class year, 23.3% of undergraduate participants were first-year students, 37.2% were second-year students, 22.1% were third-year students, 16.8% were fourth-year students, and 0.6% were "other." On average, participants had taken 7.76 STEM courses ($SD = 10.78$, range: 0–92). As in Studies 1 and 2, we examined whether there were differences in the number of STEM courses taken between the included and excluded participants. There was no difference in number of STEM courses taken between included participants, $M = 7.76$, $SD = 10.78$, and excluded participants, $M = 10.80$, $SD = 10.82$; $t(307) = -.88$, $p = .382$. The 10 participants who failed the attention check in this study were women.

Procedure

We used the same procedure from Study 1. The main change to the study was that the narrative for Study 3 followed an undergraduate woman, named Rosalia, in her environmental science class and the difficulties she encountered with getting credit for her ideas in her group: The professor seemed to favor the men in the group (see Online Appendix B at http://journals.sagepub.com/doi/suppl/10.1177/0361684318754528). These events lead Rosalia to doubt herself and question whether she should pursue science. Participants completed the same questions from Studies 1 and 2 after they finished reading the narrative. As in Study 1, participants were also assigned to fiction versus autobiography and first-, second-, or third-person narratives, but these conditions were not analyzed for the present research. In addition, participants completed a shortened version of the Attitudes toward Women in Science Scale (Erb & Smith, 1984; Stake, 2003), with 7 items rated on a 1 (*strongly disagree*) to 5 (*strongly agree*) scale ($\alpha = .91$). The measure was developed with male and female adolescent samples, and the items ask participants to consider statements about women in science such as, "A successful career is as important to a woman as it is to a man" (Erb & Smith, 1984, p. 393). This scale has shown high internal reliability as well as convergent validity with perceptions of scientists (e.g., Image of Science and Scientists Scale; Erb & Smith, 1984) and has been used with both adolescent and college samples (Owen et al., 2007).

Results and Discussion

As in Studies 1 and 2, using a MANOVA, we found a statistically significant difference in attributions based on participant gender: $F(6, 336) = 5.47$, $p < .001$; Wilks's $\Lambda = .91$, $d = .63$. Conceptually replicating the results of Studies 1 and 2, men were significantly less likely than women to attribute Rosalia's doubt to awareness of stereotypes (see Table 1). Replicating Study 1, men were significantly less likely than women to attribute Rosalia's doubt to the instructor's treatment (see Table 1). Replicating Study 2, men were significantly more likely than women to attribute Rosalia's doubt to her lack of preparation, and marginally more likely than women to attribute her doubt to her inability to cope (see Table 1). There were no gender differences in attributing her doubt to a perceived lack of support or her ability (see Table 1).

We implemented a Bonferroni correction for the three non-attribution questions, resulting in a corrected α level of $p = .017$. Men were significantly less likely than women to believe that Rosalia's experiences were similar to those of other women in college science classes (see Table 2). Furthermore, men were significantly less likely than women to perceive the instructor as being affected by both conscious and unconscious biases (see Table 2).

Finally, attitudes toward women in science significantly mediated attributing Rosalia's doubt to instructor treatment and lack of preparation. The mediation analyses were performed using PROCESS for SPSS with Model Four. For instructor treatment, gender was entered as the independent variable (X), attributing Rosalia's doubt to instructor treatment was entered as the outcome variable (Y), and attitudes toward women in science was entered as the mediator variable (M). As expected, there was a significant positive relation, $\beta = .57$, $t(340) = 2.94$, $p = .004$, 95% CI [0.19, 0.95], between gender and attributing Rosalia's doubt to instructor treatment, such that women were more likely to attribute Rosalia's doubt to instructor treatment. There was also a significant positive relation between gender and positive attitudes toward women in science, $\beta = .39$, $t(340) = 4.09$, $p < .001$, 95% CI [0.20, 0.57]. The test of mediation using bootstrapping analyses revealed that attitudes toward women in science mediated the relation between gender and attributing Rosalia's doubt to instructor treatment, $\beta = .93$, $t(339) = 9.38$, $p < .001$, 95% CI [0.73, 1.12]. Attitudes toward women in science also mediated the relation between gender and attributing Rosalia's doubt to lack of preparation, $\beta = -.51$, $t(339) = -4.21$, $p < .001$, 95% CI [−0.75, −0.27]. The mediation model was not significant for attributing Rosalia's doubt to awareness of negative stereotypes ($Z = -1.66$, $p = .10$).

Study 3 partially replicated the findings from Studies 1 and 2. As in Studies 1 and 2, men were significantly less likely than women to attribute anxiety to bias-related factors. In addition, replicating the finding from Study 2, but not Study 1, women were significantly less likely than men to attribute doubt to lack of preparation. Across the first three studies, women were consistently more likely to attribute the female student's anxiety and doubt to bias-related factors and were more likely to think that the narrative was similar to what women actually experience in STEM. Replicating the finding from Study 2, women were more likely than men to see the instructor as being influenced by unconscious biases. However, unlike in Studies 1 and 2, the women participants in Study 3 were more likely than men to see the instructor as being influenced by conscious biases. Across all three studies, there were no gender differences in attributing emotion to perceived lack of support. Finally, positive attitudes toward women in science mediated the relations between gender and attributing Rosalia's doubt to instructor treatment and lack of preparation.

A potential difference between Study 3 and Studies 1 and 2 was the assumed ethnicity of the main character. More participants perceived Trisha as White (53%) than Rosalia (28%). However, the main findings replicated, indicating that although the race perceptions changed, the effect of gender remained largely the same. This demonstrates that the results conceptually replicated when the character in the story was perceived as not of White ethnicity and that participants can detect the ethnicity difference, lending credence to the strength of the gender attributional bias effect.

Meta-Analysis

Based on current guidelines in psychology (Goh, Hall, & Rosenthal, 2016), we conducted an internal meta-analysis of the results across the three studies described above. The goal of this internal meta-analysis was to shed light on the consistency of the gender effects on attributions for anxiety in science narratives.

Method

We analyzed a set of random effects meta-analysis models, with standardized mean difference as the effect size, using the metafor package in *R* (Viechtbauer, 2010; Version 1 9-9). Each attribution was submitted to a separate meta-analysis to assess the consistency of the gender effect across the studies. Three additional meta-analyses were run on the non-attribution questions.

Results and Discussion

As shown in Table 1, across the three studies, there were medium effects such that men were less likely to attribute the undergraduate woman's anxiety to awareness of stereotypes or the instructor's treatment and were more likely to attribute the anxiety to a lack of preparation. In addition, across the three studies, there was a medium effect; men were significantly less likely than women to think that the main character's experiences were similar to those of other women in STEM. Furthermore, there was a medium effect, such that men were significantly less likely than women to report that the instructor was influenced by unconscious biases, and a small effect, such that men were marginally less likely to report that the instructor was influenced by conscious biases. Finally, the effects of gender on attribution were not significant for inability to cope, lack of social support, or lack of ability.

The meta-analyses provide further support for the hypothesis that gender can influence how individuals understand narratives about ambiguous stereotype situations. Men were more likely than women to attribute women's anxiety and doubt in STEM contexts to internal factors, such as a lack of preparation, whereas women were more likely than men to attribute women's anxiety and doubt to external factors, such as awareness of stereotypes. Furthermore, men were less likely to perceive the narratives as reflecting real-life situations and less likely to think that the instructor was affected by biases. There were no gender differences in the meta-analysis in attributing the character's emotions to ability, perceived lack of support, or inability to cope.

General Discussion

In a set of three studies and a meta-analysis, we found evidence that men and women sometimes attribute women's anxiety and doubt in a STEM class to different causes. Specifically, men were less likely than women to attribute these emotions to factors relating to stereotype threat, including awareness of stereotypes (meta-analytic $d = -.33$) and instructor treatment ($d = -.27$). In addition, men were more likely than women to attribute women's negative emotions in STEM classes to women's level of preparation ($d = .28$). A meta-analysis showed that men and women were equally likely to attribute anxiety and doubt to ability ($d = .12$), perceived lack of support ($d = .08$), and inability to cope ($d = .14$). Finally, in Study 3, we provided evidence that broader attitudes toward women in science are related to making attributions about emotion based on instructor treatment and lack of preparation. In all three studies, we used a story in which there was ambiguous bias on the part of the instructor, and the undergraduate woman in the story felt anxiety about the class or self-doubt. We believe that our stories accomplished the goal of conveying ambiguous bias, as there were no floor or ceiling effects with the two questions about bias; both were rated on a 1–9 scale, and the means and *SD*s are as follows: Instructor was affected by unconscious biases, $M = 5.84$, $SD = 1.73$; instructor was affected by conscious biases, $M = 5.01$, $SD = 1.82$. Furthermore, the responses ranged from 1 to 9 for both unconscious and conscious biases, with 2.4% and 3.8% of participants selecting 1 for unconscious and conscious biases, respectively, and 5.7% and 2.3% selecting 9 for unconscious and conscious biases, respectively.

The results of Studies 2 and 3 were fairly similar, even though the narratives had two key differences. First, the negative emotion (anxiety) was portrayed in the narrative in Study 2 as due to struggling in a class, whereas the negative emotion (doubt) was portrayed in the narrative in Study 3 as due to failing to get credit for an idea. Second, the two narratives presented two different STEM contexts: Physics (Study 2) is highly male dominated, whereas environmental science (Study 3) is not (National Science Foundation, 2017). Given these differences, it is notable that the results replicated across the two studies.

The results of Study 3 indicate that one factor mediating the relationship between gender and attributions is how women and men feel about women in science. The more positively individuals feel toward women in science, the more they attribute a woman's negative emotions in a STEM context toward external rather than internal causes. As the mediation analyses were exploratory, it will be important for researchers to continue to examine the connection between attitudes toward women in science and emotional attributions to women in science. One key issue with the Attitudes toward Women in Science measure in the present sample was that the range of responses was somewhat restricted, and the responses were skewed toward indicating more positive attitudes toward women in science: The responses were on a 1–5 scale and ranged from 2.14 to 5 ($M = 4.00$, $SD = .88$). Thus, it is possible that there are response-bias issues with the scale in this context that should be considered in future research.

One possible explanation for the gender differences found in the present study is that women may have been better than men at decoding the main character's emotional experience. For instance, a recent meta-analysis on gender differences in nonverbal displays of emotion found that women tend to be better than men at correctly identifying emotional expression (Thompson & Voyer, 2014). Yet the meta-analytic effect size for this finding was small, indicating that if gender differences in emotion detection are relevant for the present findings, it is likely that they would only account for a small piece of the puzzle. We view this possibility as less likely because the character's emotional reaction was explicitly described in the narrative rather than merely implied; however, future research should consider whether men and women would show a similar attribution style as in the present research, in a study in which the target main character, the instructor, was a man. According to a meta-analysis on emotion detection (Thompson & Voyer, 2014), women have the greatest advantage over men in accurately detecting emotion when the target is a man.

If the present findings are due to a greater awareness of stereotypes on the part of women, or a form of the intergroup attribution bias, women's responses to a male character in a STEM context should differ from men's. On the other hand, if the findings are due to gender differences in emotion decoding, women would respond the same to a male character in STEM. In the present study, men and women responded the same to a woman in STEM. One potential issue with understanding emotion decoding in the present study is that the research did not use manipulation checks to ensure that all participants correctly identified Trisha as anxious and Rosalia as self-doubting. It is possible that some participants failed to identify these emotions in the story. However, the emotions were explicitly mentioned in the story and the attribution questions (e.g., "To what extent do you believe that Trisha's anxiety during the test was caused by her awareness of negative stereotypes about women's ability to excel in science?"). Thus, it is unlikely that many participants were unaware of the emotion the character was experiencing.

In contrast to previous work on gender and attributions, the present research focused on attributions for emotional states (i.e., anxiety and doubt) rather than outcomes (i.e., failures and successes). Of note, neither story portrayed a woman failing in STEM. In fact, in the story in which Trisha struggles, her exam grade is a B−, which is not a failing grade. In the Rosalia story, Rosalia is part of a high-performing team but is not being given credit for her good ideas. The stories depicted the emotional difficulties that can accompany trying to succeed in a class when there are obstacles in the way of that success. The present research sheds light on the ways in which men and women construe these obstacles when biases may be at play. Women, compared to men, were more likely to perceive the narratives as depictions that were like real-life events and were more likely to interpret the protagonists' emotional struggles as resulting from their experience and awareness of bias. It is possible that the men were less aware of the biases women face in STEM and therefore less likely to think that the protagonist's emotions would be related to bias. Although the present research did not measure awareness of bias, prior work indicates that women report more awareness of gender biases than men (e.g., Luzzo & McWhirter, 2001; Pietri et al., 2017). On the other hand, it is possible that the men in the study were not less aware of bias, but rather that they do not believe that there are systemic biases against women in science (Handley, Brown, Moss-Racusin, & Smith, 2015). It will be important for researchers to examine whether bias awareness or bias disbelief affects emotional attributions in a STEM context.

The findings from the present research contribute to the idea that gender bias literacy is necessary to help combat STEM-related bias. A key aspect of creating successful interventions to combat the systemic bias faced by women in STEM is increasing knowledge of those biases and how they affect women (Carnes et al., 2012; Sevo & Chubin, 2008). The present research adds to the literature on gender bias literacy by suggesting that emotions and emotion attribution should be added to curriculum on STEM-related bias.

Finally, understanding how gender influences emotional attribution is an important addition to the literature on attribution theory. Previous work on gender and attributions has found that both men and women tend to interpret women's emotions as stemming from internal causes (i.e., dispositional attributions) and men's emotions as stemming from external causes (i.e., situational attributions; Barrett & Bliss-Moreau, 2009). In other words, women are seen as more emotional than men. Men interpret women's emotional expression as stemming from internal attributes rather than their situations (Barrett & Bliss-Moreau, 2009). In addition, an individual is more likely to make a situational attribution for an ingroup member's negative behavior and a dispositional attribution for an outgroup member's negative behavior (Hewstone, 1990; Pettigrew, 1979). The present results extend these findings by showing that men and women differ in how they attribute a woman's anxiety and doubt in a STEM field.

Limitations and Future Research Directions

We focused on how men and women perceive women in STEM, thus only woman protagonists were depicted in the story. That is, the present results are unable to speak to how men and women differ in how they view men and women in STEM in terms of emotional attributions. Future research can consider whether women, for example, are reluctant to see bias against men as causing emotions such as doubt and anxiety in certain situations. For example, researchers might examine how women would interpret the doubt a man might feel in entering a field such as nursing, which is woman-dominated.

Another consideration for future research is how the influence of gender on attributing women's emotions in STEM contexts might differ in a different sample. In the present set of studies, the narratives were about undergraduate women, and undergraduate participants were the target sample of interest. However, the underrepresentation of women in STEM is particularly pronounced at the graduate school levels and in the workforce. For example, despite the fact that women represent 48% of the workforce, women occupy only 24% of STEM-related jobs (Beede et al., 2011). Furthermore, 41.7% of bachelor's degrees in mathematics are awarded to women, but only 28.9% of doctorates (National Science Foundation, 2017). It is therefore crucial for researchers to help us understand how graduate students and individuals working in STEM fields interpret the causes of women's emotions in STEM situations.

It will also be important for researchers to examine the specific STEM contexts (e.g., physics vs. environmental science) more closely in the future to determine how they differ in the domain of attribution. It is possible that if Study 2 had included only physics majors as participants, and if Study 3 had included only environmental science majors as participants, the results would have been different. Men and women in physics, versus environmental science, are likely to have had different academic and gender-related experiences that may have influenced their responses to narratives about those academic domains.

In Studies 1 and 2, there was a relatively high rate of exclusion based on the attention checks and those excluded from the study were more likely to be men (Studies 1 and 2) and to have taken fewer STEM classes (Study 2). In addition, the narratives were fairly long, which may have contributed to the lack of attention to details and thus the relatively high exclusion rate. The students got credit for completing the study, regardless of how well they paid attention to the narrative, and it is possible that students were not incentivized to pay attention. The fact that more women and students who had taken more STEM courses were more likely to have paid attention may speak to the subject matter. However, in Study 3, there were very few participants excluded for a failed attention check, and similar findings emerged between Studies 2 and 3.

Students were recruited across all majors and potential majors, as the goal of the present research was to examine the role of gender in emotional attributions in a STEM context, but not necessarily with only STEM majors. At many institutions, non-STEM majors are still required to take a certain number of STEM courses in order to graduate, and both majors and non-majors are in STEM classes and likely make attributions about their classmates. In future research, it will be important to examine more tightly constrained samples to examine whether there is a difference in attribution styles among men and women in particularly male-dominated STEM fields (e.g., physics) versus less male-dominated fields (e.g., biology). Finally, in all three studies, we used a measure of attribution that was created for the purpose of the present research, based on face validity and not a standardized measure. Given the nature of the questions (i.e., responses to an original narrative), it was not possible to use a standardized measure from previous research. As future research continues to use narratives to understand emotional attributions in STEM contexts, it will be important to validate the scores on these measures across multiple studies and multiple narratives.

Practice Implications

As researchers continue to develop and empirically test bias-reduction interventions in STEM (e.g., Moss-Racusin et al., 2014), a key question to consider is how those interventions can most effectively use narrative elements to guide or influence perceptions of the subjective experience of a stereotype-targeted individual. Although we did not assess self-reported experiences of gender biases in STEM, we did find that men are both less likely to view the narratives as being similar to real-life and more likely to attribute the main characters' emotions to internal causes. In addition, prior results related to self-reported bias indicate that men are less likely to experience gender-bias related events (Luzzo & McWhirter, 2001; Swim, Hyers, Cohen, & Ferguson, 2001). Thus, it is possible that it may be particularly difficult for those who have not experienced gender-related STEM bias to understand its emotional effects. Prior calls for empirically validated scientific diversity interventions have emphasized the importance of targeting both explicit biases against women and more implicit biases that stem from the stereotype of men being more competent scientists (Moss-Racusin et al., 2014). Narratives can play an important role in these bias-related interventions. For example, in both video (Pietri et al., 2017) and story (Kaufman & Libby, 2012) interventions, narratives were successfully used to decrease biases. Researchers have found that when using narratives as tools to change attitudes, the more an individual is able to take on the experience of a narrative character, the more his or her attitudes can shift (Kaufman & Libby, 2012). The results of the present research indicate that there may be important boundary conditions on narrative interventions that have affected both men and women. That is, it is possible that under certain conditions, narratives may be broadly successful (i.e., with both men and women) and that under other conditions, narratives may be more narrowly successful. For example, in the present research, we created narratives with ambiguous instances of bias. Narratives with more unambiguous presentations of bias may be better at reaching broader audiences, as readers might need less familiarity with those situations to fully grapple with the issues presented. It will be important for researchers to consider these potential boundary conditions in future research and in the creation of future interventions.

One of the differences between the Trisha stories and the Rosalia story points to the importance of considering not just performance anxiety but also belongingness uncertainty when creating narrative-based interventions for combating gender biases in STEM. In the Rosalia story, she experienced self-doubt and belongingness uncertainty because she was worried that her opinions were devalued due to her identity as a woman in STEM. In other words, she was likely experiencing social identity threat, a broader category of threat (Steele, Spencer, & Aronson, 2002) than stereotype threat. As she was concerned about being devalued in the STEM context, her belongingness was what she felt most uncertain about. Social identity threat can lead to concern that one will be rejected, which can, in turn, reduce motivation and make one wonder if he or she will struggle to belong in the environment (Cohen & Garcia, 2008; Steele et al., 2002; Walton & Cohen, 2007). Thus, it is critical for researchers creating narrative interventions to provide ways for readers to understand the effect of both stereotype threat and the broader category of social identity threat.

The present results are applicable to the reactions women may receive when they share their own stories of experiences in STEM classes. For instance, a woman who tells a male STEM teaching assistant about her anxieties may encounter negative attributions, which in turn could increase her anxieties. As colleges and universities seek to increase the retention of women in STEM, it will be important for them to make instructors aware of how stereotype threat can lead to anxiety and self-doubt and to underscore the importance of not assuming that these negative emotions are due to internal causes such as lack of preparation or skills. Thus, moving forward, an essential component of the training and professional development of educators at all levels will be activities that aim to increase gender bias literacy—and the continued investigation and validation of techniques that most effectively achieve this aim.

Conclusions

Across three studies, the results from the present research contribute to the understanding of how men and women interpret bias-related obstacles for women in STEM. Specifically, we showed that women, but not men, attribute a woman protagonist's anxiety and self-doubt to bias-related experiences in a STEM class. As researchers create more empirically based interventions to combat bias in STEM (Moss-Racusin et al., 2014), it will be important to understand the ways in which both men and women interpret the effect of ambiguous, and more blatant instances of, bias in STEM situations.

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Supplemental Material

Supplementary material for this article is available online.

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