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Gender Bias in STEM Fields: Variation in Prevalence and Links to STEM Self-Concept

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Abstract

The current study focuses on girls' and women's reported experiences with gender bias in fields related to science, technology, engineering, and math (STEM). In the first set of analyses, I examined whether the prevalence of self-reported gender bias varied depending on the educational context. I then examined whether experiencing gender bias was associated with lower STEM self-concept and, if so, whether having a supportive network of STEM peers would buffer this effect. Data were collected through a self-report survey that was administered to high school girls who aspired to have STEM careers, women in STEM undergraduate majors, and women in STEM doctoral programs. Overall, 61% of participants reported experiencing gender bias in the past year, but the prevalence rate varied according to their phase of education and field of study. In particular, women in math-intensive undergraduate majors were especially likely to encounter gender bias, which predominately originated from male peers in their major. As expected, participants who encountered gender bias had lower STEM self-concept than participants who did not. However, this effect was attenuated for participants who also had a supportive network of STEM peers. These findings suggest that positive peer connections may be a valuable resource for girls and women in the STEM pipeline.

Keywords

sex differences, sexism, academic achievement, academic self-concept

> If we're going to out-innovate and out-educate the rest of the world, we've got to open doors for everyone. We need all hands on deck, and that means clearing hurdles for women and girls as they navigate careers in science, technology, engineering, and math. (Michelle Obama, First Lady of the United States, The White House Briefing Room, 2011)

The U.S. workforce has experienced an influx of women in recent decades. Nonetheless, there remains a stubborn gender gap in many careers related to science, technology, engineering, and math (STEM; American Association of University Women [AAUW], 2010; National Science Foundation [NSF], 2012). This gap becomes larger as girls and women progress from one phase of education to the next, and it is especially pronounced in math and math-intensive fields such as physics and engineering (NSF, 2012).

Many researchers have sought to understand why STEM fields show continued gender disparities (see Halpern et al., 2007). One controversial possibility is that gender bias is partially responsible for pushing girls and women away from STEM. Although some scholars have argued that gender bias is no longer prevalent in STEM fields (e.g., Ceci, Williams, & Barnett, 2009), recently scholars have provided evidence to the contrary (e.g., Leaper & Brown, 2008; Moss-Racusin, Dovidio, Brescoll, Graham, & Handelsman, 2012). Their work strongly suggests that at least some girls and women encounter bias in their pursuit of STEM careers.

In the current study, I examined girls' and women's reported experiences with gender bias in STEM with two goals. First, I sought to identify the most frequent perpetrators of bias and to identify the educational contexts in which gender bias is most prevalent. Second, I examined whether experiencing gender bias would be associated with lower STEM self-concept and, if so, whether having a supportive network of STEM peers would buffer this effect. In the sections that follow, I begin with an overview of past research examining gender bias in STEM. I then provide a rationale for considering links among gender bias, STEM self-concept, and peer supportiveness.

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Prevalence of Gender Bias in STEM

Many scholars agree that gender bias was once fairly common in STEM fields (see Ceci, Ginther, Kahn, & Williams, 2014; Wang & Degol, 2013). However, the question of whether gender bias constitutes a contemporary barrier for girls and women in STEM elicits more disagreement. For example, after conducting an extensive review of the literature, Ceci and colleagues concluded that there is little evidence of gender bias in STEM fields and claimed that the gender gap in STEM cannot be attributed to gender bias (Ceci et al., 2009; see also Ceci & Williams, 2010). However, recent empirical work shows evidence of continued gender bias in STEM fields. For example, Leaper and Brown (2008) found that over half of the adolescent girls in their sample had experienced academic discouragement in domains related to math and science. Women in STEM undergraduate majors and STEM graduate programs also report experiencing gender bias (Etzkowitz, Kemelgor, & Uzzi, 2000; Herzig, 2004; Margolis, Fisher, & Miller, 2000; Steele, James, & Barnett, 2002). Oftentimes the bias they encounter is subtle (e.g., social isolation and exclusion from academic discourse), but some women also report encountering overt hostility (Etzkowitz et al., 2000; Margolis et al., 2000). These self-report findings are consistent with findings from a recent experimental study, which showed that STEM faculty members rated applicants to a lab manager position more positively when the applicants were men as opposed to women (Moss-Racusin et al., 2012). Thus, both self-report and experimental research indicate that gender bias may be a challenge for at least some girls and women in STEM fields.

One factor that contributes to the prevalence of gender bias in STEM is that bias appears to come from a variety of interpersonal sources (see Halpern et al., 2007). At the high school level, some evidence suggests that male peers are the most common source of gender bias (Leaper & Brown, 2008), but there is also evidence of bias originating from female peers, teachers, and other adults (Breakwell, Vignoles, & Robertson, 2003; Kessels, 2005; Leaper & Brown, 2008). Similar to girls in high school, women in college and graduate school also report encountering gender bias from multiple sources (e.g., Etzkowitz et al., 2000; Herzig, 2004). However, little is known about the relative occurrence of bias originating from these sources because systematic comparisons are uncommon. To shed light on this issue, the current research compares the prevalence of bias originating from four interpersonal sources that girls and women in STEM fields are likely to encounter: male peers, female peers, teachers/professors, and mentors. I draw a distinction between male and female peers because prior research suggests that male peers may be an especially common source of gender bias (Leaper & Brown, 2008). A parallel distinction is not made for teachers, professors, and mentors because I did not have a priori expectations about gender differences in the level of gender bias from these groups. This line of reasoning is consistent with research suggesting that male and female faculty may show similar levels of gender bias (Moss-Racusin et al., 2012).

Gender bias and the educational context. As a whole, the research described thus far suggests that gender bias may be an enduring problem in STEM fields. However, previous work typically fails to consider whether the prevalence of gender bias varies among STEM fields. Moreover, little is known about whether gender bias differs in severity at different points in the educational pipeline. There is good reason to believe that the prevalence of gender bias varies as a function of both factors. As described below, bias may be especially prevalent in fields in which women are more severely underrepresented (Kabat-Farr & Cortina, 2014; Kanter, 1977) and, relatedly, fields in which women's presence constitutes a greater challenge to existing status hierarchies (e.g., Rudman, Moss-Racusin, Phelan, & Nauts, 2012). Examining this possibility is important because it may help researchers and policymakers develop interventions that target girls and women who are at the greatest risk of encountering gender bias in their pursuit of STEM careers (Sonnert, Fox, & Adkins, 2007; Wang & Degol, 2013).

Variation across STEM fields. Researchers who examine women's standing in STEM fields often focus on a single field or combine multiple fields into a monolithic STEM construct (e.g., Herzig, 2004; Moss-Racusin et al., 2012). However, women's representation and subjective experiences are far from uniform across STEM fields (Ceci & Williams, 2010; Wang & Degol, 2013). Indeed, after finding clear evidence of women's uneven representation in STEM disciplines, Sonnert and colleagues (2007) argued that "gender segregation by field is still in full force and shows no signs of abating" (p. 1352).

On the whole, girls and women are better represented in fields related to the life sciences than they are in math-intensive fields such as the physical sciences, computer science, engineering, and math itself (see Ceci & Williams, 2010; Perez-Felkner, McDonald, Schneider, & Grogan, 2012). This trend persists throughout the educational pipeline. For example, at the high school level, girls are less likely than boys to take Advanced Placement exams in the physical sciences, math, and computer science but are more likely to take Advanced Placement exams in biology and environmental science (AAUW, 2010). Similar trends can be found in STEM degree attainment among undergraduates and graduate students. For instance, women currently earn over half of all doctoral degrees in biology, but this percentage drops to less than one third in fields such as physics, engineering, and math (AAUW, 2010).

After observing these patterns in a recent review, Wang and Degol (2013) argued that understanding variation in women's standing across STEM fields should be a priority for future research (see also Sonnert et al., 2007). In the current study, I respond to this call by building on prior work that has distinguished between women's standing in the life sciences and their standing in math and math-intensive fields (Ceci & Williams, 2010; Perez-Felkner et al., 2012). Specifically, analyses examine whether the prevalence of gender bias is greater in math-intensive fields than in the life sciences.

Variation across phases of education. It is uncommon for researchers to compare the prevalence of gender bias at different phases of education. However, several scholars have speculated that gender differences in STEM attrition may be due to increases in the amount of bias that girls and women face as they move through the educational pipeline (e.g., Committee on Science, Engineering, and Public Policy, 2007; Etzkowitz et al., 2000; Herzig, 2004). This possibility is consistent with theory and research indicating that women may encounter negative reactions when they violate hierarchies in which men tend to hold positions of power (e.g., Glick & Fiske, 1996; Rudman et al., 2012). For instance, Rudman and colleagues (2012) found that female leaders were especially likely to encounter backlash when they threatened the gender status quo by demonstrating high levels of agency. By extension, gender bias may become a more serious barrier as girls and women move into increasingly prestigious, male-dominated academic spheres, which could help to explain why the gender gap in STEM is wider at the doctoral level than it is in earlier phases of education. I explore this possibility by comparing rates of gender bias in STEM across three phases of education: high school, college, and graduate school.

Implications of Experiencing Gender Bias

A second goal of the current research was to shed light on the implications of experiencing gender bias by examining whether experiencing gender bias is associated with lower STEM self-concept. STEM self-concept refers to the extent to which individuals believe they are capable of excelling in STEM fields (see Simpkins, Davis-Kean, & Eccles, 2006). A large body of theoretical and empirical work illustrates that self-concept plays a central role in academic decision making. For example, according to expectancy-value theory, individuals' beliefs about their ability to succeed in a given domain are a key determinant of their academic and career trajectories (Eccles & Wigfield, 2002). Similarly, social–cognitive career theory argues that individuals' beliefs about their capabilities shape their career choices (Lent & Brown, 1996). Both theories have generated an abundance of empirical support, and much of this work illustrates that self-concept predicts achievement and career aspirations in STEM domains (DeBacker & Nelson, 2000; Robnett, Chemers, & Zurbriggen, 2015; Robnett & Leaper, 2013; Watt, 2006). This underscores the importance of identifying factors such as gender bias that have the potential to negatively influence girls' and women's STEM self-concept.

The models outlined in both expectancy-value theory and social–cognitive career theory provide theoretical support for the prediction that experiencing gender bias may lead to lower STEM self-concept. Specifically, according to these perspectives, self-concept is informed by the social context and social interactions. For instance, Eccles (1994) proposed that socializers such as teachers and peers play a key role in shaping students' academic self-concept (see also Wang & Degol, 2013). Along a similar vein, Lent and colleagues (2001) argued that self-efficacy can be influenced by contextual barriers such as discrimination or a lack of social support. It merits noting that these social–contextual barriers are thought to present challenges regardless of whether they are objectively documented or subjectively perceived (Lent & Brown, 2006; Settles, Cortina, Buchanan, & Miner, 2013; Wang & Degol, 2013).

My recent literature search indicates that only one prior study has directly linked experiences with gender bias to self-concept in STEM domains. Namely, Brown and Leaper (2010) found that high school girls who experienced gender bias felt less competent in math and science than did other participants. I build on this work by assessing the implications of gender bias in a broader array of academic contexts. Moreover, analyses are limited to girls and women who are already in the STEM pipeline in order to shed light on how gender bias influences those who have a vested interest in their STEM achievement.

Supportive network of STEM peers as a buffer. If gender bias is indeed associated with lower STEM self-concept, it is important to identify factors that can mitigate its effects. Hence, the final goal of the current study was to examine whether having a supportive network of STEM peers can buffer the negative implications of experiencing gender bias. Individuals often rely on social support when they encounter general challenges as well as challenges that are specific to bias and discrimination (e.g., Ayres & Leaper, 2013; Lazarus & Folkman, 1984; Wasti & Cortina, 2002). Moreover, a number of studies from the field of social psychology indicate that positive peer connections can promote academic retention for underrepresented students (e.g., Walton & Cohen, 2007). The proposed mechanism underlying this effect is belongingness (e.g., Cheryan, Plaut, Davies, & Steele, 2009). That is, positive connections with STEM peers likely foster girls' and women's sense of belongingness in STEM, which may in turn enhance their likelihood of retention by tempering the self-doubt that stems from negative social interactions (see Dasgupta, 2011; Walton & Cohen, 2007).

On the basis of prior research focusing on social support and belongingness, I examined whether the negative association between experiencing gender bias and STEM self-concept would be attenuated among girls and women who report having a supportive network of STEM peers. I assumed positive peer connections would be beneficial regardless of the gender composition of the peer network. This assumption was guided by minimal group research demonstrating that undergraduates' math persistence and motivation improve when they feel a sense of connection with their math peers, even if they are not provided with information about their peers' gender or other background characteristics (Walton, Cohen, Cwir, & Spencer, 2012, experiment 2).

The Current Study

To summarize, I sought to fill several gaps in prior research that focuses on gender bias in STEM fields. First, I conducted analyses to identify the most common perpetrators of gender bias in STEM. Drawing from Leaper and Brown's (2008) study focusing on gender bias in an adolescent sample, the following hypothesis was tested:

> **Hypothesis 1:** Gender bias originating from male peers will be significantly more common than gender bias originating from female peers, teachers/professors, or mentors.

I also examined whether the prevalence of gender bias varied depending on the educational context. Because women are especially likely to encounter gender bias when they are in the numerical minority within a given setting (Kabat-Farr & Cortina, 2014; Kanter, 1977; Rudman et al., 2012), gender bias was expected to be most prevalent in STEM domains that have lower levels of gender equity. Specifically, the following hypotheses were tested:

> **Hypothesis 2a:** Participants who are pursuing an education in math-intensive fields (i.e., computer science, engineering, math, and physical sciences) will report experiencing more gender bias than will participants who are pursuing an education in the life sciences (i.e., biology, ecology, and health sciences).
> **Hypothesis 2b:** The prevalence of gender bias will increase incrementally according to phase of education. That is, women who are pursuing STEM doctoral degrees will report experiencing the most gender bias, followed by women who are pursuing STEM bachelor's degrees. STEM-focused high school girls will report experiencing the least gender bias.
> **Hypothesis 2c:** The two-way interaction between participants' phase of education and field of study will be significant, such that women pursuing graduate degrees in math-intensive fields will experience particularly high rates of gender bias relative to other participants.

The current study also builds on prior research by examining the implications of experiencing gender bias. Given that self-concept is thought to be shaped by the social context (Eccles & Wigfield, 2002), I tested for a link between experiencing gender bias and participants' STEM self-concept. Thus, the third hypothesis is as follows:

> **Hypothesis 3:** There will be a negative association between gender bias and STEM self-concept, such that participants who experience more bias will have lower STEM self-concept.

Last, if experiencing gender bias is indeed associated with lower STEM self-concept, it is important to identify factors that may mitigate this effect. Prior research suggests that having a supportive peer network may reduce the negative implications of experiencing gender bias (e.g., Ayres & Leaper, 2013). Hence, the final hypothesis is as follows:

> **Hypothesis 4:** The association between experiencing gender bias and STEM self-concept will be attenuated for participants who have a supportive network of STEM peers.

Method

Participants

High school. Girls were recruited from math and science classes at two high schools in the western United States. As an incentive, participants were entered into a raffle to win one of several US$50 gift certificates. In total, 400 girls participated. However, analyses for the present study focused on a subset of 108 girls who reported that they were interested in pursuing a STEM career. Their mean age was 16.57 years ($SD = .95$). Sixty-eight (63%) participants planned to pursue a major in the life sciences, and 40 (37%) participants planned to pursue a major in math-intensive fields. With respect to ethnic background, 37 (34%) participants identified as Asian American, 52 (48%) identified as European American, 15 (14%) identified as Latina, and 4 (4%) identified as multiple/other.[1] Although a direct measure of socioeconomic background was not obtained, the majority of participants reported that their parents had completed at least a bachelor's degree (70 mothers [65%] and 78 fathers [72%]).

Undergraduate and graduate. Data collection at the undergraduate and graduate levels took place at a public, 4-year university in the western United States. The university's Carnegie Classification indicates that it is *more selective* and has *very high research activity*. The student body, collapsing across undergraduates and graduate students, is 48% men and 52% women. The gender distribution in STEM majors is comparable to U.S. national averages. For instance, in physics, women earned 24% of the bachelor's degrees (national average: 21%) and 20% of the doctoral degrees (national average: 17%) in the year when the data collection took place.

Undergraduate participants were recruited through e-mails, course announcements, and flyers. Participants were entered into a raffle to win one of several US$50 gift certificates. To be included in the present study, participants needed to be majoring (or premajoring) in a STEM field. In total, 124 women participated. Their mean age was 20.28

years ($SD = 1.74$). Sixty-three (51%) undergraduate participants were pursuing degrees in the life sciences, and 61 (49%) were pursuing degrees in math-intensive fields. With respect to ethnic background, 29 (23%) participants identified as Asian American, 52 (42%) identified as European American, 22 (18%) identified as Latina, and 21 (17%) identified as multiple/other. Over half of the participants reported that their parents had obtained at least a bachelor's degree (68 mothers [55%] and 64 fathers [52%]).

Graduate participants were recruited through e-mails, course announcements, and flyers. All graduate participants received gift certificates that ranged in value from US$10 to US$20. (To improve the pace of recruiting, the incentive was increased from US$10 to US$20 early in the data collection process.) To be included in the present study, participants needed to be pursuing a doctoral degree in a field related to STEM. In total, 102 women participated. Their mean age was 28.36 years ($SD = 5.05$). Seventy-one (70%) participants were pursuing degrees in math-intensive fields, and 31 (30%) were pursuing degrees in the life sciences. With respect to ethnic background, 19 (19%) participants identified as Asian American, 63 (62%) identified as European American, 9 (9%) identified as Latina, and 10 (10%) identified as multiple/other. The majority of participants reported that their parents had obtained at least a bachelor's degree (65 mothers [64%] and 77 fathers [75%]).

Procedure

Data collection occurred during the spring semesters of 2011 and 2012. The research team that was responsible for recruiting and survey administration included 11 women; 1 was a graduate student who identified as White, 8 were undergraduates who identified as White, and 2 were undergraduates who identified as Biracial. As described below, recruiting and data collection differed somewhat depending on participants' phase of education.

High school. Math and science teachers were provided with basic information about the study and the logistics of data collection. They then received parental consent forms to send home with their students. The consent forms explained that students were invited to participate in a study that focuses on links between students' peer networks and their academic interests. Approximately one month after the consent forms were sent out, members of the research team returned to each class to administer the survey. All high school participants completed the survey during their math or science classes, which were 50 minutes in duration. All of the students who started the survey were able to finish within the class period. Students who did not participate worked on other assignments.

Undergraduate and graduate. To recruit undergraduate and graduate students, the research team made announcements during STEM courses, posted flyers in STEM departments, and sent e-mails to students in STEM fields of study. Prospective participants were told that the aim of the study was to better understand students' experiences in STEM fields. Due to the nature of the recruiting process, it is not possible to calculate the exact response rate. However, the response rates for undergraduates and graduate students who were recruited via e-mail were 124 (26%) and 102 (38%), respectively. Undergraduate and graduate students who agreed to participate were provided with a link to an online survey, which took about 40 minutes to complete. Attrition rates were fairly low. Specifically, eight undergraduates (6% of the full undergraduate sample) and three graduate students (3% of the full graduate sample) stopped on the first or second page of the survey. Their data are not included in the forthcoming analyses.

Measures

Participants completed a survey that included questions about their experiences with gender bias in STEM, their STEM self-concept, and the supportiveness of their STEM peers. The survey also included several additional constructs that were not the focus of the current study.[2] There were slight wording differences among the surveys used for high school students, undergraduate students, and graduate students. For simplicity, the examples provided throughout the remainder of this section are for undergraduates majoring in a science field.

Field of study. The current study distinguished between the life sciences and math-intensive STEM fields, a distinction that has been made in prior theoretical and empirical work (e.g., Ceci & Williams, 2010; Perez-Felkner et al., 2012; Sonnert et al., 2007). In order to classify high school students according to their field of study, participants were asked to select their preferred college major from a list of 50 possible majors. (As noted earlier, students who selected a non-STEM major were not included in the current study.) College and graduate students were classified according to their current field of study. Disciplines including biology, ecology, and health sciences were classified as *life sciences*, whereas disciplines including the physical sciences, math, engineering, and computer science were classified as *math-intensive*.

Gender bias. Experiences with gender bias in STEM were assessed with an adaptation of a measure that Leaper and Brown (2008) used in a study that focused on adolescent girls' experiences with gender bias in STEM. Thus, the adaptations made in the current study involved tailoring the wording of prompt and response options so that the measure would be suitable for students in all three phases of education. For example, high school students were asked about bias originating from *teachers*, whereas college and graduate students were asked about bias originating from *professors*.

Before completing the measure, participants were presented with the following prompt:

> Gender bias occurs when people treat women unfairly *due to their gender*. Some women have experienced gender bias in science fields, but others have not. We would like to know about *your experiences with gender bias in your major over the past year.*[3]

Following the prompt were eight forms of academic gender bias: (1) "Made negative comments about women's science abilities," (2) "Expected less of you academically or professionally because of your gender," (3) "Made you feel like you had to work harder than male students to be taken seriously," (4) "Made you feel like your gender will make it difficult for you to succeed in STEM," (5) "Excluded you from a STEM study group because of your gender," (6) "Excluded you from a discussion about STEM because of your gender," (7) "Made negative comments about your ability in STEM because of your gender," and (8) "Ignored your comments or questions in STEM classes because of your gender." For each item, participants rated how frequently the following people behaved in that manner: male peers from their major (science classes, graduate program), female peers from their major (science classes, graduate program), teachers/professors from their major (science classes, graduate program), and a mentor/advisor. Participants made frequency ratings on a 4-point scale (1 = *never*, 2 = *once or twice*, 3 = *several times*, and 4 = *many times*). The frequency ratings for each form of bias were averaged together to create mean gender bias scores for each of the four perpetrators as well as an overall gender bias score. Higher scores on these scales reflect more frequent experiences with bias.

The internal reliability for gender bias originating from each of the four perpetrators was acceptable for high school students (male peers: $\alpha = .85$, female peers: $\alpha = .62$, teachers: $\alpha = .78$, and mentors: $\alpha = .75$), college students (male peers: $\alpha = .92$, female peers: $\alpha = .87$, professors: $\alpha = .84$, and mentors: $\alpha = .85$), and graduate students (male peers: $\alpha = .89$, female peers: $\alpha = .69$, professors: $\alpha = .86$, and mentors: $\alpha = .85$). However, it merits noting that reliability was somewhat lower for female peers than it was for the other three sources of gender bias. The internal reliability for the overall gender bias measure was also acceptable for high school students ($\alpha = .89$), college students ($\alpha = .94$), and graduate students ($\alpha = .95$). These internal reliabilities are consistent with values obtained in prior research. For example, in a study carried out with high school students, Leaper and Brown (2008) reported an α of .85 for their measure of gender bias.

STEM self-concept. The self-expectancy scale from Eccles's expectancy-value measure (Eccles & Wigfield, 2002) was used to assess participants' self-concept in STEM. All items were rated on a 4-point scale. The scale was composed of 10 items such as "If you were to order all of the students in your major from the worst to the best, where would you stand?" (1 = *one of the worst* and 4 = *one of the best*) and "How much effort would you need to do well in an advanced science course?" (1 = *a lot* and 4 = *almost none*). Higher scores on this scale reflect higher STEM self-concept.

The internal reliability was acceptable for high school students ($\alpha = .91$), undergraduate students ($\alpha = .88$), and graduate students ($\alpha = .86$). These internal reliabilities are consistent with values obtained in prior research. For instance, in a study carried out with high school students, Simpkins and colleagues (2006) reported an α of .85 for math/science self-concept. Similarly, in a study carried out with college students, Durik, Shechter, Noh, Rozek, and Harackiewicz (2015) reported an α of .84 for math self-concept.

Supportiveness of STEM peer network. To assess the supportiveness of the STEM peer network, participants were first presented with a prompt that asked them to respond to each item with their STEM peers in mind. That is, high school students rated peers from their math or science classes, undergraduate students rated peers from their major, and graduate students rated peers from their graduate program. Following this prompt were 9 items that were adapted from a measure that Stake and Mares (2001) used to assess peer relationships that developed during a science enrichment program for high school students. As before, the wording of this measure was modified so that it would also be appropriate for students in college and graduate school. Sample items include "My interactions with other science majors have made me more self-assured as a science student" and "My interactions with other science majors have made studying science more enjoyable." Each item was rated on a scale ranging from 1 (*strongly disagree*) to 6 (*strongly agree*), and higher score reflects a more supportive STEM peer network.

The internal reliability of this measure was acceptable for high school students ($\alpha = .87$), undergraduate students ($\alpha = .83$), and graduate students ($\alpha = .88$). These internal reliabilities are consistent with values obtained in prior research. For example, in a study carried out with high school students, Stake and Mares (2001) reported αs of .85 (pretest) and .83 (posttest) for their measure of peer support.

Results

Preliminary Analyses

To test for ethnic differences in study variables, multivariate analyses of variance (MANOVAs) compared mean levels of self-concept, peer support, and gender bias for participants who identified as Asian American, European American, or Latina. The MANOVAs were carried out separately for participants in high school, college, and graduate school. The MANOVA for high school students was nonsignificant, Wilks' $\Lambda = .90$, $F(6, 196) = 1.75$, $p = .12$, $\eta_p^2 = .05$, and the MANOVA for graduate students was only marginally significant, Wilks' $\Lambda = .87$, $F(6, 166) = 2.02$, $p = .07$, $\eta_p^2 = .07$. The MANOVA for undergraduates, however, was significant, Wilks' $\Lambda = .84$, $F(6, 186) = 2.76$, $p = .02$, $\eta_p^2 = .08$. Follow-up univariate ANOVAs carried out with the undergraduate participants indicated that there were not significant ethnic differences in the extent to which participants viewed their STEM peers as supportive, $F(2, 101) = .40$, $p = .67$, $\eta_p^2 = .01$, nor were there significant ethnic differences in the amount of gender bias that participants reported experiencing, $F(2, 101) = .39$, $p = .68$, $\eta_p^2 = .01$. In contrast, the ANOVA for STEM self-concept was significant, $F(2, 101) = 8.52$, $p < .001$, $\eta_p^2 = .15$. Post hoc pairwise comparisons using the Bonferroni test revealed that among undergraduates, STEM self-concept was significantly higher in European American participants ($M = 2.46$, $SD = .49$) than it was in Asian American participants ($M = 2.06$, $SD = .40$, $p = .03$). For this reason, all forthcoming analyses control for participants' ethnic background.

A second MANOVA tested for field of study differences in peer support and STEM self-concept. (Mean differences in gender bias are reported in the main analyses below.) The MANOVA was nonsignificant, Wilks' $\Lambda = .99$, $F(2, 319) = .80$, $p = .45$, $\eta_p^2 = .01$, which indicates that levels of peer support and self-concept did not significantly differ for participants in math-intensive fields versus the life sciences. In contrast, a third MANOVA that tested for phase of education differences in peer support and STEM self-concept was significant, Wilks' $\Lambda = .92$, $F(4, 658) = 6.78$, $p < .001$, $\eta_p^2 = .04$. Follow-up univariate ANOVAs indicated that there were significant field of study differences in the extent to which participants viewed their STEM peers as supportive, $F(2, 332) = 7.40$, $p = .001$, $\eta_p^2 = .04$, and in participants' STEM self-concept, $F(2, 332) = 4.83$, $p = .01$, $\eta_p^2 = .03$. With respect to peer support, post hoc pairwise comparisons using the Bonferroni test revealed that participants in high school ($M = 4.15$, $SD = .77$) reported significantly lower levels of peer support than did participants in college ($M = 4.46$, $SD = .88$, $p = .01$) and graduate school ($M = 4.57$, $SD = .79$, $p = .001$). With respect to STEM self-concept, post hoc pairwise comparisons using the Bonferroni test revealed that participants in college ($M = 2.29$, $SD = .49$) had significantly lower STEM self-concept than did participants in high school ($M = 2.49$, $SD = .57$, $p = .01$).

A final MANOVA was carried out among the graduate students to examine whether participants who received a US$10 gift card incentive differed from participants who received a US$20 gift card incentive. The MANOVA was nonsignificant, Wilks' $\Lambda = .98$, $F(3, 91) = .64$, $p = .58$, $\eta_p^2 = .02$. Hence, all graduate students are grouped together in the forthcoming analyses.

Variation in the Prevalence of Gender Bias: Hypotheses 1 and 2

Descriptive statistics. Overall, 204 (61%) of girls and women in the current study reported experiencing gender bias in STEM at least once over the course of the past year. The most frequently experienced forms of gender bias included *feeling as though you had to work harder than male students to be taken seriously* (reported by 130 [39%] participants) and *hearing negative comments about girls' and women's STEM abilities* (reported by 127 [38%] participants). The prevalence of gender bias is further broken down according to source, phase of education, and field of study in Table 1. The percentages in the table provide preliminary evidence of variation in the prevalence of gender bias. For instance, 70% ($n = 43$) of women in math-intensive undergraduate majors reported experiencing gender bias from male peers; the corresponding percentage for undergraduate women in the life sciences was 50% ($n = 32$). Parametric analyses formally testing for variation in gender bias are described next.

Table 1. Percentage of Participants Who Experienced Gender Bias From Male Peers, Female Peers, Professors, and Mentors.

	% Who Experienced at Least Once During the Past Year			
	High School	College	Graduate	Overall
Male peers in STEM				
Life science	58	50	18	49
Math-intensive	46	70	41	52
Female peers in STEM				
Life science	28	32	27	30
Math-intensive	28	43	34	36
A STEM teacher or professor				
Life science	21	29	14	23
Math-intensive	18	43	42	37
A mentor or advisor in STEM				
Life science	30	24	18	26
Math-intensive	21	32	24	26

Note. Sources of gender bias are sorted in descending order according to their overall prevalence in the sample. STEM = science, technology, engineering, and math.

Mean differences in the prevalence of bias. A mixed repeated-measures ANCOVA was carried out to test Hypotheses 1 and 2. The goal of this analysis was to determine whether mean levels of gender bias varied according to the source of bias (Hypothesis 1) as well as according to participants' field of study and phase of education (Hypothesis 2). The within-subjects variable was the source of bias (male peer, female peer, teacher/professor, and mentor); the between-subjects variables were participants' field of study (math-intensive, life sciences) and their phase of education (high school, college, and graduate). Ethnicity was included in the model as a covariate. Below, findings pertaining to the source of gender bias (within-subjects effects) are presented first, followed by findings that address field of study and phase of education differences in the prevalence of gender bias (between-subjects effects).

Within-subjects effects. The repeated-measures ANCOVA revealed a main effect for source of gender bias, $F(3, 909) = 28.64$, $p < .001$, $\eta_p^2 = .09$. Post hoc pairwise comparisons using the Bonferroni test provided support for Hypothesis 1.

Specifically, the mean level of gender bias originating from male peers ($M = 1.32$, $SD = .51$) was significantly higher than the mean level of bias originating from female peers ($M = 1.11$, $SD = .21$, $p < .001$), teachers/professors ($M = 1.13$, $SD = .29$, $p < .001$), and mentors ($M = 1.11$, $SD = .29$, $p < .001$).

Between-subjects effects. Analyses also revealed significant between-subjects main effects. First, there was a main effect for field of study, $F(1, 303) = 8.57$, $p = .004$, $\eta_p^2 = .03$. Consistent with Hypothesis 2a, girls and women in math-intensive fields ($M = 1.20$, $SD = .19$) reported significantly higher rates of gender bias than did girls and women in the life sciences ($M = 1.12$, $SD = .19$). There was also a main effect for phase of education, $F(2, 303) = 5.96$, $p = .003$, $\eta_p^2 = .04$. Post hoc pairwise comparisons using the Bonferroni test provided partial support for Hypothesis 2b. Namely, women in college ($M = 1.22$, $SD = .31$) reported experiencing significantly more gender bias than did girls in high school ($M = 1.13$, $SD = .20$, $p = .01$), which was hypothesized, but they also reported experiencing significantly more gender bias than did women in graduate school ($M = 1.15$, $SD = .30$, $p = .02$), which was not hypothesized.

The two aforementioned main effects were qualified by a two-way interaction between field of study and phase of education, $F(2, 303) = 3.10$, $p = .04$, $\eta_p^2 = .02$. Figure 1 presents mean levels of gender bias as a function of participants' field of study and phase of education. To probe the interaction, univariate ANOVAs were first carried out to assess field of study effects separately for participants in high school, college, and graduate school. Findings illustrated that among undergraduates, experiences with gender bias were significantly more common among women in math-intensive fields ($M = 1.32$, $SD = .38$) than they were among women in the life sciences ($M = 1.14$, $SD = .22$), $F(1, 111) = 9.23$, $p = .003$, $\eta_p^2 = .08$. The same pattern was also found for graduate students, although the mean difference was only marginally significant, $F(1, 91) = 3.07$, $p = .08$, $\eta_p^2 = .03$. In contrast, rates of gender bias did not significantly differ according to field of study for participants in high school, $F(1, 105) = .003$, $p = .96$, $\eta_p^2 = .00$.

To further examine the interaction, a second set of univariate ANOVAs tested for phase of education effects separately for participants in the life sciences and math-intensive fields. A significant main effect was obtained for participants in math-intensive fields, $F(2, 165) = 5.78$, $p = .004$, $\eta_p^2 = .07$. Post hoc pairwise comparisons with the Bonferroni test demonstrated that undergraduate women in math-intensive fields ($M = 1.32$, $SD = .38$) reported experiencing significantly more gender bias than did their counterparts in high school ($M = 1.12$, $SD = .21$, $p = .006$) and graduate school ($M = 1.16$, $SD = .29$, $p = .05$). Significant phase of education effects were not obtained for girls and women in the life sciences, $F(2, 144) = 1.64$, $p = .20$, $\eta_p^2 = .02$.

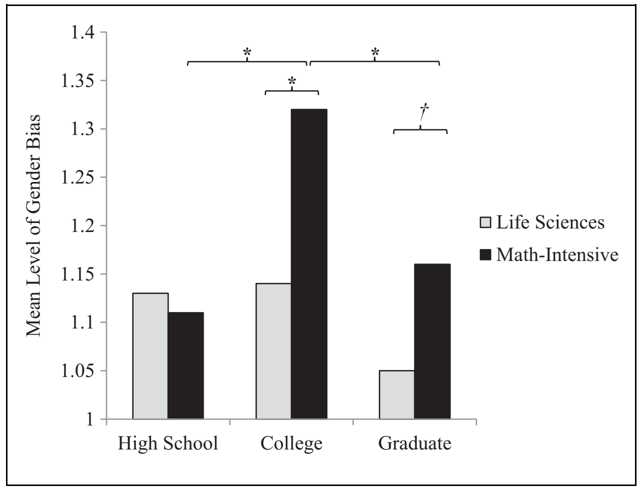

Figure 1. Depiction of the two-way interaction between phase of education and field of study. *$p < .01$. †$p < .10$.

The findings from the phase of Education × Field of Study interaction indicate that the main effects of field of study and phase of education were largely driven by undergraduate women in math-intensive fields of study. Specifically, women who were pursuing undergraduate degrees in math-intensive fields reported significantly higher rates of gender bias relative to other participants. This is inconsistent with Hypothesis 2c, which predicted that graduate students, not undergraduates, in math-intensive fields would experience the highest rates of gender bias.

Gender Bias, STEM Self-Concept, and Peer Support: Hypotheses 3 and 4

Multiple regression was used to examine whether higher rates of perceived gender bias were associated with lower STEM self-concept (Hypothesis 3). Analyses also considered whether the association between gender bias and STEM self-concept would be attenuated for participants who had a supportive network of STEM peers (Hypothesis 4). Control variables in the regression model included ethnicity, phase of education, and field of study. Predictor variables of relevance to the hypotheses included mean levels of gender bias and peer support as well as the two-way interaction between gender bias and peer support. Both continuous predictor variables were mean centered prior to computing the interaction term.

Results of the multiple regression are reported in Table 2. The overall model was significant, $F(7, 310) = 6.61$, $p < .001$, and it accounted for 13% of the variance in participants' STEM self-concept. Two of the control variables were significantly associated with STEM self-concept: European American participants had significantly higher STEM self-concept than did participants from other ethnic groups, and undergraduates had significantly lower STEM self-concept than

Table 2. Multiple Regression Testing Predictors of STEM Self-Concept.

	b	*SE*	β	*t*	*p*
Ethnicity (0 = *ethnic minority*, 1 = *White*)	.24	.06	.23	3.85	<.001
Phase of education					
High school (0 = *college*, 1 = *high school*)	.26	.07	.23	3.64	<.001
Graduate (0 = *college*, 1 = *graduate*)	.05	.07	.05	.71	.48
Field of study (0 = *life sciences*, 1 = *math-intensive*)	.07	.06	.07	1.17	.24
Peer support	.09	.04	.15	2.63	.009
Gender bias	−.24	.11	−.12	−2.23	.03
Bias × Support	.30	.13	.13	2.33	.02

Note. Gender bias and peer support were centered prior to computing the interaction term. STEM = science, technology, engineering, and math.

did high school students. In addition, having a more supportive STEM peer network was associated with significantly higher STEM self-concept. Last, consistent with Hypothesis 3, higher rates of gender bias were associated with significantly lower STEM self-concept.[4]

The two-way interaction between gender bias and peer support was also significant. To probe the interaction, the simple slope for gender bias was assessed at 1 *SD* below the peer support mean (−.84) and at 1 *SD* above the peer support mean (.84). Peer support was mean centered prior to carrying out the regression. As illustrated in Figure 2, findings provided support for the buffering effect predicted in Hypothesis 4. Specifically, gender bias was negatively associated with STEM self-concept when participants had a less supportive network of STEM peers ($\beta = -.49$, $p < .001$). In contrast, the association between gender bias and STEM self-concept was nonsignificant when participants had a more supportive network of STEM peers ($\beta = .01$, $p = .93$).

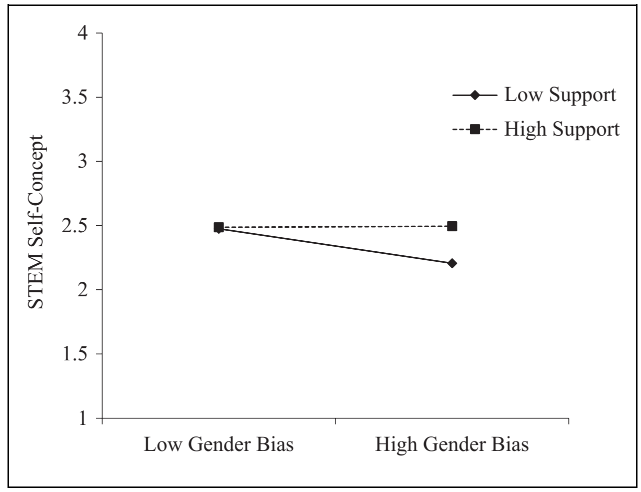

Figure 2. Plot of the two-way interaction between gender bias and peer support. The simple slope for gender bias was assessed at 1 *SD* below the peer support mean (−.84) and at 1 *SD* above the peer support mean (.84). The simple slope is significant at 1 *SD* below the mean ("low support"), whereas it is nonsignificant at 1 *SD* above the mean ("high support").

Discussion

In the current study, I focused on girls' and women's experiences with gender bias in STEM fields. A key goal was to examine whether perceptions of gender bias varied in prevalence depending on the source of bias as well as participants' phase of education and field of study. Although the majority of participants reported experiencing gender bias, experiences with bias were especially common for women who were enrolled in math-intensive undergraduate majors. The present study also found that experiencing gender bias was associated with lower STEM self-concept, but that this effect was mitigated among participants who also had a supportive network of STEM peers. Below, the findings are described in more detail, and several implications for intervention and outreach are highlighted.

Prevalence of Gender Bias

Overall, 61% of participants in the current study reported experiencing gender bias at least once during the past year. This finding aligns with recent research indicating that girls and women encounter gender bias in their pursuit of STEM careers (e.g., Moss-Racusin et al., 2012) but differs from several reviews that find little evidence of gender bias in STEM fields (e.g., Ceci et al., 2009; Ceci & Williams, 2010). In determining what might lead researchers to these disparate conclusions, it may be informative to distinguish between formal discrimination and interpersonal discrimination. *Formal discrimination*, which is often overt, pertains to unfair treatment in hiring, promotion, and access to resources, whereas *interpersonal discrimination*, which is often subtle, pertains to negative interpersonal encounters (Hebl, Foster, Mannix, & Dovidio, 2002). The current study focused on interpersonal discrimination, which is a common focus of research that finds evidence of gender bias in STEM fields (e.g., Leaper & Brown, 2008; Steele et al., 2002). In contrast, most of the studies that do not find evidence of gender bias focus on formal discrimination (e.g., Ceci et al., 2009). Taken together with prior research, findings from the present study suggest that gender bias in STEM fields may be following a trend that has been observed in society on the whole, whereby interpersonal discrimination persists despite declines in more formal forms of discrimination (see Hebl et al., 2002). This is not to say that formal discrimination has been eradicated (see Moss-Racusin et al., 2012; Settles et al., 2013), but rather that it may be less common relative to interpersonal discrimination.

The results of the current study also add to a growing body of evidence demonstrating that male peers are a more common source of gender bias in STEM than are female peers, teachers/professors, and mentors (for a similar pattern, see Leaper & Brown, 2008). Notably, some prior work indicates that at the college and graduate levels, it is not uncommon for women to encounter male peers who make remarks about women being accepted into STEM programs on the basis of their gender rather than their academic credentials (Etzkowitz et al., 2000; Margolis et al., 2000). It is possible that negative interactions like these help to explain why over a third of participants in the current study reported that others in STEM made them feel as though they needed to work harder than male students to be taken seriously. Beyond causing frustration, this type of double standard may contribute to the gender gap in STEM fields to the extent that it erodes girls' and women's sense of belongingness in their area of study (Cheryan et al., 2009; Murphy, Steele, & Gross, 2007).

Variation in the prevalence of gender bias. Findings also showed that the prevalence of gender bias varied depending on the educational context. As expected, participants in math-intensive fields reported higher rates of gender bias relative to participants in the life sciences. Also, in partial support of expectations, undergraduates reported higher rates of gender bias than did participants in other phases of education. However, an interaction effect illustrated that these two main effects could be attributed to particularly high rates of bias encountered by women in math-intensive undergraduate majors. This pattern was somewhat unexpected because prior research suggests that the prevalence of gender bias may be higher in domains in which women are more underrepresented (Kabat-Farr & Cortina, 2014; Kanter, 1977), thus leading to the prediction that women in math-intensive graduate programs would experience the most bias.

There are several potential explanations for the high rates of gender bias reported by undergraduates, as opposed to graduate students, in math-intensive fields. First, this pattern would be explained if women who perceive high levels of gender bias exit the STEM pipeline before matriculating to the doctoral level. On the other hand, it is also possible that gender bias is simply more common in college than it is in graduate school. To understand why this might be the case, it is worthwhile to consider the competitive "weed out" culture that characterizes some math-intensive undergraduate majors (see Etzkowitz et al., 2000). Specifically, undergraduates in math-intensive majors are sometimes required to prove themselves in difficult gateway courses that are designed to filter out less capable students. Consequently, some men may feel uncertain about their status in the major, which could contribute to high rates of gender bias. This possibility is consistent with work indicating that men are especially likely to engage in backlash against women when their status is threatened (Rudman et al., 2012). Along this vein, Stake (2003) demonstrated that adolescent boys who were low in their science self-confidence were especially likely to hold negative views about women in science. Notably, her findings also showed that if boys' science self-confidence increased over time, there was a corresponding reduction in their negative views about women in science. Thus, if men in math-intensive undergraduate majors feel less confident in their academic status compared to their counterparts at the graduate level, it could help to explain why undergraduate women in math-intensive majors report experiencing particularly high rates of gender bias. Of course, this possibility is speculative and should be empirically tested.

Implications of Gender Bias

Beyond shedding light on the prevalence of gender bias, I examined whether encountering bias is associated with negative implications for girls and women in STEM. Consistent with hypotheses, experiencing higher levels of gender bias was associated with lessened STEM self-concept. This pattern accords with theoretical work proposing that features of the social environment inform individuals' self-concept (Eccles, 1994; Lent & Brown, 2006). It is also a troubling pattern, given that longitudinal research has linked self-concept to important academic and career outcomes (see Wang & Degol, 2013, for a review). For example, Watt (2006) found that girls' math self-concept predicted their future course-taking and career aspirations in math. Similar longitudinal work has illustrated that science self-efficacy predicts subsequent changes in the extent to which undergraduates identify with science (Robnett et al., 2015). Thus, from an applied standpoint, the negative association between gender bias and STEM self-concept underscores the potential value of interventions and outreach that aim to reduce gender bias and mitigate its negative effects.

These arguments raise the question of whether the association between gender bias and STEM self-concept, although statistically significant, has practical importance. Although it is not possible to provide a definitive answer to this question on the basis of the current study's findings, there is good reason to believe that even small statistical effects can have substantial real-world implications. For instance, Martell, Lane, and Emrich (1996) used a computer simulation to demonstrate that gender bias led to women being underrepresented at the top of organizational hierarchies, even when the bias accounted for only 1% of the variance in hiring decisions.

The buffering role of peer support. Having established that experiencing gender bias is associated with lessened STEM self-concept, the current study next examined whether this association would be attenuated for participants who had a supportive network of STEM peers. This hypothesis was grounded in research showing that positive peer connections can foster a sense of belongingness, which tends to be especially important for students who are underrepresented in their area of study (Cheryan et al., 2009; Dasgupta, 2011; Walton & Cohen, 2007). Findings supported the hypothesized buffering effect: Women who encountered gender bias were relatively high in their STEM self-concept as long as they also had a supportive network of STEM peers. Those who did not have a supportive network, however, had relatively low STEM self-concept. This pattern suggests that the consequences of gender bias are lessened if girls and women also have a supportive peer network in their area of study. Future research should examine whether support networks involving family members or friends outside STEM confer similar benefits (see Ong, Wright, Espinsoa, & Orfield, 2011).

Practice Implications

Currently, many researchers, educators, and policymakers are dedicating resources to intervention work that aims to correct gender imbalances in STEM fields. Unfortunately, these interventions too often have limited success (see Weisgram & Bigler, 2007). Some researchers have suggested that intervention efforts could be made more effective by tailoring them to the challenges that girls and women encounter in specific STEM fields (see Sonnert et al., 2007). The results of the current study indicate that this may be a worthwhile strategy. Although many participants reported experiencing gender bias regardless of their phase of education or field of study, experiences with bias were especially common for women who were pursuing undergraduate degrees in math-intensive fields. Hence, interventions that aim to reduce the prevalence of gender bias may be especially beneficial for women in math-intensive undergraduate majors.

Interventions that target gender bias could take several forms depending on whether the goal is to reduce gender bias itself or to reduce its negative consequences. With respect to reducing gender bias, efforts to educate faculty and students about creating a more inclusive climate would be helpful. Given that male peers were the most common source of gender bias in the current study, it is particularly important to reach them with messages about the value of promoting gender equity. Research suggests that these messages may have a particularly strong impact if they are explicitly endorsed by departmental leadership (Fox, 2000).

Because some gender bias is likely to linger after even the most intensive interventions, working to reduce its negative implications is also important. The results of the present study show that having a supportive network of STEM peers may serve this purpose. Thus, interventions that aim to foster social ties among STEM students may be useful (e.g., Dasgupta, 2011). Another worthwhile approach would be to promote existing outreach organizations such as Women in Science and Engineering (e.g., https://wise.usc.edu/) that bring STEM students together outside of the classroom.

Limitations and Future Directions

The current research has several limitations. First, the findings should be evaluated with an eye toward their generalizability. Data were collected from students at two high schools and one university in the western United States. Thus, it is possible that the patterns of gender bias that were obtained are specific to a particular region of the United States or to particular institutions. A counterpoint to this concern is overlap between the gender bias prevalence rates reported in the current study and the rates reported in other research. For example, 61% of the participants in the current study reported experiencing gender bias, and prevalence rates in similar studies range from around 50% to just over 70% (e.g., Konik & Cortina, 2008; Leaper & Brown, 2008; Sonnert, 1995).

It is also important to consider whether the present study's findings generalize to women outside of STEM. For example, in the field of political science, women are underrepresented (NSF, 2012) and may encounter negative stereotypes (e.g., Eagly & Karau, 2002). Thus, it would be worthwhile to examine whether the current study's findings can be replicated among women pursuing degrees in political science and other fields, such as economics and philosophy, in which women are also underrepresented.

A second limitation of the current study pertains to its focus on perceptions of gender bias. It is not possible to directly assess how closely these perceptions align with actual levels of gender bias in STEM fields. However, it bears noting that the self-reported experiences with gender bias that were examined in the current study may underestimate the "true" prevalence rate because individuals are often reluctant to acknowledge that they have experienced unfair treatment on the basis of their social category memberships (Crosby, 1984; Swim, Eyssell, Murdoch, & Ferguson, 2010). Such a possibility is particularly likely in the current study, given that the term *gender bias* was used in the survey measure. This is because some individuals resist using terms like *bias* or *harassment* even if they report experiencing behaviors that are consistent with those terms (e.g., Magley, Hulin, Fitgerald, & DeNardo, 1999).

It is also important to keep in mind that although perceptions have an element of subjectivity, they nonetheless have important implications for actual behavior. For example, among adolescents, perceiving high levels of racial discrimination is associated with worse academic outcomes (Benner & Graham, 2013). Similarly, one meta-analysis found that workers who perceive a negative workplace climate have lessened job performance and an enhanced likelihood of leaving their jobs altogether (Carr, Schmidt, Ford, & DeShon, 2003). It therefore follows that girls' and women's perceived experiences with gender bias may have implications for their actual retention in STEM fields. Longitudinal research would help to shed light on whether this is indeed the case.

Longitudinal research would also provide insight into the directionality of the association between gender bias and STEM self-concept. According to expectancy-value theory and social-cognitive career theory, social–contextual barriers such as gender bias are antecedent to self-concept (Eccles, 1994; Lent & Brown, 2006). However, given the cross-sectional nature of the present study, it is not possible to rule out the reverse causal direction. That is, perhaps girls and women who have lower self-concept elicit greater levels of gender bias from others in STEM. Longitudinal research would clarify this question by assessing whether experiencing gender bias is associated with subsequent declines in self-concept. As well, longitudinal research carried out at the institutional level would provide insight into the potentially cyclical nature of the association between gender bias and women's representation in STEM. For example, it seems plausible that increasing the number of women in a given STEM major could reduce the level of gender bias, which may in turn draw more women into the major.

Another worthwhile direction for future research would be to examine whether the outcomes of gender bias are influenced by the gender of the perpetrator. Although the current study distinguished between gender bias that originated from male peers versus female peers, this distinction was not made for gender bias that originated from professors and mentors. Thus, future research should begin by establishing whether male and female faculty members engage in differing levels of gender bias. It would then be helpful to examine whether the implications of gender bias differ depending on the gender of the perpetrator. For example, perhaps gender bias originating from male peers, teachers, and professors has a particularly strong impact, given that men tend to have high status within STEM departments. A related direction for future research pertains to considering the gender composition of girls' and women's networks of STEM peers. Minimal group research suggests that even the slightest sense of connection to one's peers can foster belongingness (e.g., Walton et al., 2012), which implies that supportive peer ties should be beneficial for girls and women in STEM regardless of whether those ties are to male peers or female peers. It may be, however, that the degree of benefit varies depending on the gender composition of the peer group. In support of this point, research indicates that connections to advanced, same-gender peers can boost women's self-concept and persistence in STEM domains (Stout, Dasgupta, Hunsinger, & McManus, 2011).

Conclusion

In conclusion, the current study's findings build on prior research in several ways. A key finding is that the prevalence of gender bias appears to vary depending on girls' and women's phase of education and field of study. In particular, a relatively high proportion of women in math-intensive majors reported experiencing gender bias, which was especially likely to come from male peers who were in their major. Findings also add to a small body of research that has linked experiences with gender bias to lessened STEM self-concept. However, the negative implications of experiencing gender bias were reduced for participants who also had a supportive network of STEM peers. Collectively, the results of the present study illustrate the importance of helping girls and women forge positive connections with their peers who are also in the STEM pipeline.

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Notes

1. Across the full sample (i.e., all phases of education and areas of study), only four (1%) participants identified as African American. This low base rate precluded the use of a standalone "African American" ethnic group category in the analyses. Thus, the African American girls and women in the sample are instead included in the "multiple/other" ethnic group category.
2. The current study is part of a larger study that focuses on predictors of students' pursuit of science, technology, engineering, and math (STEM) careers. Other constructs assessed in the larger study include mentoring, social identity, work–family conflict, and experiences with sexual harassment.
3. The sample prompt provided in text was used for undergraduates who were majoring in science fields. Participants in high school were asked about bias they experienced in their math or science classes, and participants in graduate school were asked about bias they experienced in their graduate program. In addition, the wording of the prompt was tailored to students' current field of study or, in the case of high school students, to their desired field of study. For example, for high school students who were interested in the life sciences, the last sentence of the prompt was as follows: "We would like to know about your experiences with gender bias in your science classes over the past year." In contrast, for high school students who were interested in math-intensive fields, the last sentence of the prompt was as follows: "We would like to know more about your experiences with gender bias in your math classes over the past year."

4. The hypothesized association between gender bias and STEM self-concept was also tested in a subset of participants who reported their score on the SAT Math (high school and college students) or the GRE Quantitative (graduate students). For these participants, standardized test scores were included as a control variable in the multiple regression model described above. Findings replicated the results obtained in the full sample. The association between gender bias and self-concept was significant ($\beta = -1.15$, $p = .02$), as was the two-way interaction between bias and peer support ($\beta = 1.27$, $p = .03$).

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