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Helping and Hindering Undergraduate Women's STEM Motivation: Experiences With STEM Encouragement, STEM-Related Gender Bias, and Sexual Harassment

Campbell Leaper[1] **and Christine R. Starr**[1]

Abstract

Prior research indicates many women either leave or pursue science, technology, engineering, and mathematics (STEM) degrees because the social climate undermined or strengthened their motivation and career aspirations. We investigated whether women's experiences of sexual harassment and STEM-related gender bias negatively predicted their STEM motivation (task value, competence beliefs, and perceived costs) and STEM career aspirations. We also tested whether STEM encouragement from friends and family positively predicted motivation and aspirations. To consider domain-specific effects, we also tested the predictors in relation to non-STEM motivation and career aspirations. Students' grade point average was controlled in all analyses. The sample was undergraduate women enrolled in gateway biology courses for majors ($N = 685$; $M = 19.67$ years of age; 35% Asian, 31% White, and 27% Latinx). A majority experienced gender bias (60.9%) or sexual harassment (78.1%) at least once in the past year. STEM-related gender bias from classmates and sexual harassment from instructors (faculty, teaching assistants, or graduate students) were negatively related to STEM motivation and career aspirations. Perceived STEM encouragement from friends was positively related to motivation, and STEM encouragement from friends and family predicted STEM career aspirations. Finally, domain-specific effects were indicated. Our research highlights the need for programs that increase awareness of discrimination, combat bias and harassment, and affirm students' STEM interest. *Additional online materials for this article are available on* PWQ's *website at https://journals.sagepub.com/doi/suppl/10.1177/0361684318806302*

Keywords

motivation, science, sexism, sexual harassment, teachers, peers, family

Women's underrepresentation in many science, technology, engineering, and mathematics (STEM) fields has received much attention among researchers and policy makers in recent decades (e.g., National Science Foundation, 2017). Research indicates gender disparities in STEM are largely due to underlying differences in motivation rather than in competence (e.g., O'Dea, Lagisz, Jennions, & Nakagawa, 2018; Riegle-Crumb, King, Grodsky, & Muller, 2012). That is, many women who are doing well in STEM courses ultimately elect to pursue other career options (Diekman & Fuesting, 2018; Wang, Eccles, & Kenny, 2013). The reasons underlying these decisions can be complex and vary across individuals. However, studies indicate many women leave STEM majors or careers because the social climate undermined their motivation in these fields (Cheryan, Ziegler, Montoya, & Jiang, 2017; Dasgupta & Stout, 2014; Leaper, 2015; Lewis et al., 2017; Moss-Racusin, Sanzari, Caluori, & Rabasco, 2018; Rosser, 2012).

In the present study, we examined supportive and undermining experiences in relation to undergraduate women's motivation in STEM. On the one hand, perceived encouragement for STEM achievement from friends and family may be sources of resilience that strengthen women's motivation to persist in STEM fields. On the other hand, experiencing sexual harassment or negative bias toward women in STEM from instructors, classmates, or friends may undermine women's motivation. To our knowledge, no prior studies of women's STEM motivation have considered both sexual harassment and STEM-related gender bias in the same analysis. Whereas sexual harassment may undermine women's trust in academic institutions and their general motivation (e.g., Rosenthal, Smidt, & Freyd, 2016), STEM-related gender bias may specifically affect their motivation to pursue STEM

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majors and careers (e.g., Robnett, 2016). Furthermore, our study is unique in that it has a large, ethnically diverse sample and investigates the relation of STEM-related gender bias, sexual harassment, and encouragement on motivation and career aspirations in STEM and non-STEM fields.

Understanding the gender gap in STEM is important for several reasons. First, the underrepresentation of women in STEM contributes to gender inequality in income. Somewhat paradoxically, more women than men attain college degrees in the United States and many other industrialized countries, yet women continue to lag behind men in average income (World Economic Forum, 2017). Because STEM careers are among those with the highest pay and job growth, attaining greater gender parity in these fields can help increase overall gender equality in incomes. Second, many girls and young women who are competent in STEM begin to lose interest over time due to the various obstacles they confront (Dasgupta & Stout, 2014). This means many individuals are not pursuing careers that they might find fulfilling. Finally, increasing access in STEM allows for a greater range of individuals who can help fill occupations seen as increasingly important for the society (Zakaria, 2011).

STEM Motivation and Career Aspirations

In the present study, we investigated women's experiences with STEM-related gender bias, sexual harassment, STEM encouragement, and overall college encouragement as predictors of their STEM motivation and career aspirations. Our sample was composed of women enrolled in gateway biology courses for majors in the life sciences. We considered three facets of STEM motivation (competence beliefs in STEM, task value in STEM, and perceived costs in STEM) in addition to STEM career aspirations. To test whether our hypothesized predictors had domain-specific effects on women's STEM outcomes, we also tested the predictor variables in relation to their motivation for humanities and their non-STEM career aspirations.

Our conceptualization of motivation is based on the expectancy-value theory of achievement (Eccles & Wigfield, 1995, 2002). According to this model, individuals are most motivated to achieve in domains in which they expect to succeed (e.g., confidence in ability) and they value (e.g., intrinsic interest). Longitudinal studies have revealed that students' motivation (competence beliefs or value beliefs) in a subject predicted later achievement, even after controlling for their initial performance (Eccles, 2014; Eccles & Wigfield, 2002; Watt, 2008). It is notable that average gender differences in STEM-related motivation are generally documented prior to women's dropping out of the STEM pipeline (Wang & Degol, 2013). During high school and college, average gender differences in scholastic achievement in science or math are either negligible or favor girls and women (Voyer & Voyer, 2014). However, more meaningful average gender differences in science and math competence beliefs have been observed during high school and college (Huang, 2013; Sikora & Pokropek, 2012; Syzmanowicz & Furnham, 2011).

The perceived cost associated with a domain is usually incorporated into the task value facet of the expectancy-value model (see Eccles & Wigfield, 2002). However, we chose to examine it as a separate component in the present study (see Kosovich, Hulleman, Barron, & Getty, 2015) because of our interest in identifying factors that may undermine women's STEM motivation. That is, some women may find STEM to be intrinsically interesting, yet they may simultaneously perceive potential costs to pursuing a major or a career in the field. If the costs are seen as too burdensome, women may conclude that they should not pursue STEM (see review below).

We also examined women's career aspirations in STEM and non-STEM fields. Career aspirations reflect the extent to which individuals see themselves choosing to attain a possible occupational identity in the future (Erikson, 2007; Markus & Nurius, 1986; Seginer, 2009). For a college student, aspirations for a particular occupation may affect their choices regarding courses and other experiences necessary to pursue that field (Watt, 2010). According to the expectancy-value model (Eccles & Wigfield, 2002), achievement-related choices are partly shaped by the individuals' competence beliefs (e.g., self-efficacy) and task value (e.g., intrinsic interest) regarding particular subjects. That is, adults are more likely to aspire to STEM careers if they are motivated via competence beliefs and subjective task values (e.g., Eccles & Wang, 2016; Guo, Marsh, Morin, Parker, & Kaur, 2015; Watt, 2008, 2010). However, individuals form these choices in social contexts (e.g., Robnett & Leaper, 2013; Simpkins, Fredricks, & Eccles, 2015). The support or the discouragement of others may affect how students appraise future possibilities (Erikson, 2007).

STEM-Related Gender Bias and Sexual Harassment

Recent work has called attention to the various ways that instructors, peers, and families can influence girls' and women's motivation or sense of belonging in STEM fields (see Cheryan et al., 2017; Dasgupta & Stout, 2014; Leaper, 2015; Lewis et al., 2017). Below, we review how experiences with discrimination may undermine women's motivation in STEM. In a later section, we consider how relationships can support STEM motivation.

STEM-related gender bias and sexual harassment are two forms of discrimination that we examined. The former refers to hearing negative comments about women in STEM, which send the message that women do not belong in STEM (e.g., Moss-Racusin, Sanzari, et al., 2018). The latter refers to unwanted sexual behaviors, which in an academic context may create a negative climate that broadly undermines women's motivation. In the present study, participants were asked whether they experienced STEM-related gender bias and experiences with sexual harassment originating from instructors (faculty, teaching assistants, or graduate students), classmates, and friends—as we reasoned these would be three salient and important relationships defining the academic climate for most undergraduates.

Prior studies have documented that many girls and women encounter gender-biased messages about their gender group's presumed competence or fit in STEM. For example, Leaper and Brown (2008) asked adolescent girls in the United States whether they had heard negative comments about girls in math, science, or computers. Among the respondents, 52% reported hearing these comments. Negative comments came most frequently from boys (32%), other girls (22%), and teachers/coaches (23%). Analyses also revealed that the frequency of experiencing these sexist comments about girls in science, math, and computers was negatively related to the girls' motivation (competence beliefs and task value) in math and science even after controlling for grades (Brown & Leaper, 2010). Studies conducted in Germany, Canada, and Israel similarly found that negative peer reactions to adolescent girls in science were related to lowered motivation (Boehnke, 2008; Kessels, 2005). And a recent study in the United States found that girls' observations of gender-based differential treatment in a middle school math classroom negatively predicted their math motivation and achievement in the eleventh grade (McKellar, Marchand, Diemer, Malanchuk, & Eccles, 2018).

The previously reviewed investigations focused on middle school and high school students. Undergraduates may differ from younger samples inasmuch as they are more likely to select their courses. Relatedly, they may be exploring their major and future career pathways. Two pertinent studies conducted in the United States with undergraduate samples indicated that experiences with STEM-related gender bias were associated with STEM outcomes. Robnett (2016) found that encountering gender-biased messages about women in STEM predicted lower STEM motivation in a sample of undergraduate women majoring in STEM. Similarly, Steele, James, and Barnett (2002) found that undergraduate women in male-dominated areas (mostly STEM) were more likely than women in female-dominated areas (arts, humanities, and social sciences) to experience gender-based discrimination and to consider changing their major.

Hence, in our study, we hypothesized a negative relation between experiences with STEM-related gender bias and women's STEM motivation (competence beliefs, task value, and career aspirations), even after controlling for students' grades. We further speculated that experiencing gender bias from peers (classmates or friends) may be especially pernicious, given peers are an important context for social comparison and gaining a sense of group belonging in STEM (see Robnett & Leaper, 2013). For example, classmates in one's major might be seen as representative of the kinds of colleagues they would have in future graduate programs or careers. To our knowledge, there has been little prior work directly comparing the effects of different sources of messages on STEM-related gender bias on women's STEM motivation or career aspirations.

Experience with sexual harassment is another form of gender discrimination that may undermine women's STEM motivation and aspirations. In prior studies, U.S. high school girls' experiences with sexual harassment were negatively related to school satisfaction, academic engagement, and success (e.g., American Association of University Women, 2011; Gruber & Fineran, 2016; Leaper & Brown, 2008; National Academies of Sciences, Engineering, and Medicine, 2018; Ormerod, Collinsworth, & Perry, 2008). In a recent study, Rosenthal, Smidt, and Freyd (2016) found that U.S. graduate student women's experiences with sexual harassment from faculty/staff or students were positively correlated with feelings of institutional betrayal; however, in a regression analysis, only harassment from faculty/staff was significant. Among women enrolled in gateway courses for STEM majors, experiencing sexual harassment from instructors, classmates, or school friends may lead them to associate these behaviors with pursuing a pathway in STEM.

Hence, we hypothesized a negative relation between reported sexual harassment and STEM motivation and career aspirations even after controlling for students' grades. Moreover, we speculated that sexual harassment from instructors (faculty, teaching assistants, or graduate students) may be especially malicious because these experiences could lead to feelings of institutional betrayal (Hershcovis & Barling, 2010; Smith & Freyd, 2014).

Perceived Encouragement for STEM

Experiencing encouragement for STEM from family and friends may help to bolster women's STEM motivation and act as protective factors against gender discrimination. Prior studies conducted in the United States indicate that the perceived support of family and friends for academic success can reinforce students' academic achievement. Moreover, domain-specific support may be especially helpful to sustain motivation in particular areas (e.g., Leaper, Farkas, & Brown, 2012; Riegle-Crumb, Farkas, & Muller, 2006; Robnett & Leaper, 2013). Leaper, Farkas, and Brown (2012) found that parental and peer support for math and science predicted adolescent girls' motivation in these subjects while controlling for grades. Robnett and Leaper (2013) found that experiencing friends' support for math and science predicted high school students' science career aspirations, although girls were less likely than boys to report this kind of support. The authors proposed that having a friendship group that supports science (or STEM) may foster a sense of belonging in the subject. Moreover, Robnett (2016) observed a similar relation between peer support for STEM and motivation in a sample of undergraduate women majoring in STEM.

We hypothesized that both friends' and family's support of STEM would positively predict women's motivation (competence beliefs, value, and perceived costs) and STEM career aspirations. Of particular note, we tested whether these supports would uniquely predict women's STEM motivation and career aspirations after taking into account experiences with gender discrimination. Given prior research pointing to the influence of peers on adolescents' and young adults' academic motivation (Brechwald & Prinstein, 2011; Ryan, 2000), we suspected STEM support from friends might be especially linked with undergraduate women's STEM motivation. Furthermore, to explore whether domain-specific support was important, we included a measure of overall college support from friends and family.

Domain-Specific Associations

Prior research suggests that the impact of bias or encouragement on academic motivation or career aspirations is domain specific (e.g., Leaper & Brown, 2008; Leaper et al., 2012; Riegle-Crumb et al., 2006; Robnett, 2016; Robnett & Leaper, 2013). That is, negative comments about women in STEM or encouragement for women in STEM may be more likely to affect attitudes toward STEM rather other subjects (e.g., humanities). To explore this premise of domain-specific effects, we included measures of humanities motivation and non-STEM career aspirations in the survey. We also included measures of perceived encouragement for STEM as well as perceived encouragement for college overall.

We expected that STEM-related gender bias and STEM encouragement either (1) would not be significantly related to humanities motivation and non-STEM career aspirations or (2) would have the opposite associations with humanities motivation and non-STEM career aspirations (e.g., STEM gender bias positively associated with humanities value; STEM encouragement negatively associated with non-STEM career aspirations). We expected perceived encouragement for college would be positively related to humanities motivation and non-STEM career aspirations.

Our measure of sexual harassment was not specific to STEM contexts. Women may attribute recent experiences with sexual harassment from instructors or classmates to their declared or likely major; in turn, the effect may be similar to experiencing STEM-related gender bias (e.g., experiences with sexual harassment associated with higher humanities value). Alternatively, women may associate experiences with sexual harassment to the broader university climate and therefore indicate lower motivation toward all subjects (including humanities). Therefore, we did not advance any specific hypotheses regarding the relation of experiences with sexual harassment to either humanities motivation or non-STEM career aspirations.

Summary

In the present investigation, we investigated whether experiences with discrimination and encouragement are related to the academic motivation and career aspirations of undergraduate women. Participants were enrolled in gateway biology courses for majors in the life sciences. Two forms of discrimination were evaluated: STEM-related gender bias (which may especially affect STEM outcomes) and sexual harassment (which may affect academic outcomes more generally). We also evaluated perceived encouragement for STEM and for college overall. To consider domain-specific effects, we separately tested the predictors in relation to STEM and non-STEM outcomes. We also took into account whether the source of any discrimination (instructors, classmates, or friends) or encouragement (friends or family) moderated any of the findings. Finally, we explored whether the women's status as underrepresented (UR) racial-ethnic minorities moderated the effects of the discrimination or encouragement variables on the outcome variables.

Method

Participants

The sample was composed of women enrolled in one of three gateway biology courses (described in Procedure section below) that are prerequisites for majors in the life sciences at a public university in the United States. Students were asked to complete the measures used in the present study within the first 2 weeks of a 10-week term. The present analyses focused only on the students who identified as women and who completed the survey. Of an initial sample of 711 women, 26 women were dropped due to missing values for one or more of the measures testing predictors of STEM motivation and career aspirations. Analysis of the patterns of missing data revealed that less than 1% of all items for all cases were missing, and 99.48% of the items were not missing data for any case. Considering individual cases, 95.84% of participants had no missing data. Finally, first-year grade point average (GPA) was the most common missing variable, with 16 missing values. Cases with any missing values for GPA or STEM-related measures were not used in the present study.

The sample used in the present analyses was composed of 685 women undergraduates ($M = 19.67$ years, $SD = 1.17$). The breakdown of the sample by college year was 11.5% first year ($n = 79$), 52.6% second year ($n = 360$), 30.7% third year ($n = 210$), and 5.3% fourth year or greater ($n = 36$). The participants' self-reported primary ethnic heritages were 34.7% Asian or Pacific Islander ($n = 238$), 30.8% White or European American ($n = 211$), 27.4% Latinx or Hispanic ($n = 188$), 4.5% Black or African American ($n = 31$), and 3% other or not reported ($n = 17$). In addition, according to the university's classification, 32.6% of the students ($n = 223$)

were designated as belonging to an UR ethnic-racial group (Latinx/Hispanic, Black/African American, Native American, or Native Hawaiian).

The students were enrolled in gateway biology courses for majors in the life sciences. However, only 49% of the students had officially declared or proposed their major. Of these, 97% (n = 339) were in STEM majors. Specifically, 23% were biology (n = 80), 17% human biology (n = 55), 11% molecular cellular developmental biology (n = 38), 7% marine biology (n = 24), 7% biochemistry and molecular biology (n = 16), 7% bioengineering or bioinformatics (n = 26), 7% neuroscience (n = 7%), 5% psychology or cognitive science (n = 18), 4% ecology and evolution (n = 13), 3% environmental studies (n = 11), and 3% chemistry (n = 10). Finally, five students had declared an earth science major, two in plant science, and two in physics.

Procedure

Our Institutional Review Board-approved study targeted students enrolled in three gateway introductory biology courses (described below) that are prerequisites for majors in the life sciences. The present sample was part of a larger survey study at a public university in the United States that examined classroom practices in gateway biology courses and students' course success (Starr et al., 2018). The present authors consulted on this project, and we were able to include measures in the survey to address our own research questions regarding women's experiences with STEM-related gender bias and sexual harassment in relation to their STEM motivation (described in the present study).

The three gateway courses surveyed were cell and molecular biology (two classrooms with 64 and 356 students each), development and physiology (four classrooms with 73–328 students each), and ecology and evolution (three classrooms with 72–234 students each). Students typically enroll in these courses in the sequence listed. The students in these classes (N = 2,070) were asked to complete an online survey during the first weeks of classes and again during the last 2 weeks of a 10-week term (with an additional week for final exams). The instructors provided students with partial course credit; those who did not wish to participate in the study could do an alternative assignment. All students in the courses were asked to complete the survey, although the present analyses focus only on the women. On average, the classes sampled in the study were composed of 61% women. A majority of students (63%; n = 1,312) completed the survey, with 185 students who were dropped because they had participated in multiple courses that used the survey. In the final sample of 1,127 unique student cases, 63% (n = 711) identified as women (and 26 cases were removed due to missing data).

Students were told the survey study was an investigation of students' interest and motivation in STEM and other majors. The survey included scales presented in randomized order that were designed to evaluate the following: perceived classroom learning practices, STEM motivation, humanities motivation, STEM career aspirations, current activities, future course plans, identity, classroom climate, perceptions of professor and teaching assistant (TA), feeling recognized by current instructor for science activities, perceived STEM support, self-objectification, experiences with sexual harassment, and experiences with STEM-related discrimination. Measures of classroom experience were used as part of a separate study of student success. For the present study, we used the measures of motivation, career aspirations, experiences with sexual harassment, and STEM-related discrimination. In addition, we obtained the following from the university's institutional research office: students' age, gender, race/ethnicity, UR status, first-year GPAs, and declared major. The university designates Latinx/Hispanic, Black/African American, Native American, or Native Hawaiian as UR ethnic-racial groups.

Measures

STEM and humanities motivation. To assess STEM motivation beliefs, we employed the Expectancy-Value-Cost Scale (Kosovich et al., 2015), which is based on the expectancy-value model of motivation (Eccles & Wigfield, 1995). The instrument includes three separate scales to evaluate perceived value, costs, and expectations for success (i.e., competence beliefs). We used the scales to evaluate motivation separately in STEM and the humanities. Items were rated on a 6-point scale. The authors of the scale (Kosovich et al., 2015) established evidence for the validity of the shortened version of the expectancy-value scale that we used in the current study.

The value scale included 3 items: "How important to you are your STEM [humanities] classes?" (1 = *not at all important* to 6 = *extremely important*), "How much do you value your STEM [humanities] courses?" (1 = *do not value at all* to 6 = *extremely value*), and "How useful do you consider your STEM [humanities] classes?" (1 = *not useful at all* to 6 = *extremely useful*; α = .82).

The expectations for success (competence beliefs) scale included 3 items: "How easily can you learn the material in your STEM [humanities] classes?" (1 = *cannot learn the material in my class* to 6 = *definitely can learn the material*), "How successful do you expect to be in your STEM [humanities] classes?" (1 = *definitely expect that I will be unsuccessful* to 6 = *definitely expect that I will be successful*), and "How confident are you about understanding the material in your STEM [humanities] classes?" (1 = *not at all confident* to 6 = *definitely confident*; α = .87).

The costs scale included 4 items: "How much time does your STEM [humanities] classwork usually require?" (1 = *never too much time* to 6 = *definitely too much time*), "How often do you find that you don't have time to put into your STEM [humanities] classes because of other things that you do?" (1 = *never occurs* to 6 = *almost always occurs*), "How easily can you put in the time needed to do well in your STEM [humanities] classes?" (1 = *never difficult to find time* to 6 = *extremely difficult to find time*), and "How much in your life do you have to give up to do well in your STEM [humanities] classes?" (1 = *never too much* to 6 = *definitely too much*; $\alpha = .74$).

Possible career aspirations. We adapted the Motivation for a Science Career Scale (Stake & Mares, 2001) by changing the word "science" to "STEM" in items to evaluate the extent that participants positively viewed a possible STEM career or a possible non-STEM career. Our directions (created for the present study) stated:

> In the questions below, consider your thoughts about a possible career in a STEM field . . . [such as] becoming a teacher, a professor, or a research scientist in the physical and biological sciences or engineering. STEM careers also include professions in health and medicine. And some people do work related to STEM in policy and law (for example, biomedical ethics or technology patents).

They next rated the following 4 items on a 6-point scale (1 = *strongly agree* to 6 = *strongly disagree*): "I plan to pursue a STEM career," "I could succeed in a major or graduate program needed for a STEM career," "I could succeed in a job in a STEM field," and "I would enjoy a career in STEM." The items had good internal reliability for the current sample ($\alpha = .89$). In addition, participants were asked to rate their non-STEM aspirations using the same items with "non-STEM" instead of "STEM" (e.g., "I plan to pursue a non-STEM career"). These had satisfactory internal reliability ($\alpha = .74$).

Perceived encouragement for STEM and college. Participants were asked to evaluate the degree to which they felt encouraged in STEM, and in college, overall from family and friends. The survey directions for these questions stated, "Please evaluate how strongly you feel that your family and friends respond to you as an overall student as well as a student taking any STEM (science, technology, engineering, or math) classes." There were 3 items, each regarding perceived STEM encouragement from family and friends: "My family [friends] values my success in STEM classes," "My family [friends] encourages me to study STEM," and "People in my family [friends] are interested in STEM." In addition, there were analogous questions regarding perceived encouragement for college from family and friends with the phrase "STEM" replaced with "college" in the items. All items were rated on a 6-point scale (1 = *never*, 2 = *rarely*, 3 = *occasionally*, 4 = *sometimes*, 5 = *usually*, and 6 = *always*). Internal reliability for the current sample on these items was satisfactory regarding STEM support from family ($\alpha = .73$) and friends ($\alpha = .77$) as well as for college support from family ($\alpha = .69$) and friends ($\alpha = .79$).

Perceived sexual harassment. We assessed women's experiences with sexual harassment from (a) faculty, teaching assistants, or graduate students (referred to collectively in this article as instructors); (b) classmates; or (c) friends in separate questions (derived from Leaper & Brown, 2008). The directions read:

> Sexual harassment includes the following: unwelcome sexual behaviors (comments, jokes, gestures, or pictures); being called gay or lesbian in a negative way; unwanted sexual attention or contact (comments about appearance, unwanted touch); sexual bullying or sexual threats; other unwanted sexual behaviors. Within the last year (12 months), how often have you experienced sexual harassment?

Participants were then asked to rate frequency of occurrence on a 6-point scale (1 = *never*, 2 = *1–2 times in last* year, 3 = *3–6 times in last year*, 4 = *6–12 times in last year*, 5 = *13–24 times in last year*, and 6 = *more than 24 times in last year*) separately for "faculty, teaching assistants, or graduate students"; "classmates"; and "friends."

Perceived gender bias in STEM. We evaluated women's experiences with gender bias in STEM from (a) faculty, teaching assistants, or graduate students (referred to collectively in this article as instructors); (b) classmates; or (c) friends (derived from Leaper & Brown, 2008). The directions read:

> Bias in academic settings occurs when students are treated differently based on their backgrounds . . . . A few examples of bias include group-based favoritism, negative comments about people's abilities based on a group identity, or patronizing comments based on one's group identity. These experiences may occur in the classroom or other settings.

After this preliminary description, the survey asked: "Within the last 12 months how often have you experienced any kind of *bias toward women* related to STEM (science, math, computers, or engineering) [original emphasis]?" The word "computers" rather than "technology" was used here to make the association more explicit to potentially relevant majors (e.g., computer science). Participants were then asked to rate frequency of occurrence on a 6-point scale (1 = *never*, 2 = *1–2 times in last* year, 3 = *3–6 times in last year*, 4 = *6–12 times in last year*, 5 = *13–24 times in last year*, 6 = *more than 24 times in last year*) separately for "faculty, teaching assistants, or graduate students"; "classmates"; and "friends."

Results

Preliminary Analyses

Descriptive statistics and bivariate correlations. Table 1 summarizes the descriptive statistics and bivariate correlations among the STEM-related measures. Our four outcome variables (STEM value, competence beliefs, costs, and career

Table 1. Descriptive Statistics and Bivariate Spearman Correlations With STEM Motivation and Career Aspiration Variables.

Variable	GPA	STEM Value	STEM Competence	STEM Costs	STEM Career	Teachers' Bias	Classmates' Bias	Friends' Bias	Instructors' Harass	Classmates' Harass	Friends' Harass	Family STEM	Friends STEM	Family College	Friends College
GPA	—	.043	.191***	−.158***	.060	−.003	−.026	−.016	−.036	−.060	−.068*	.035	−.020	−.010	−.060
STEM value	—	—	.300***	.002	.362***	.040	−.088*	−.015	−.068*	−.074*	−.071*	.151***	.233***	.134***	.217***
STEM competence	—	—	—	−.284***	.456***	.000	−.063*	−.031	−.046	−.026	−.085*	.173***	.231***	.133***	.237***
STEM costs	—	—	—	—	−.093**	.110**	.246***	.193***	.005	.162***	.167***	−.078*	−.074*	−.097**	−.121**
STEM career	—	—	—	—	—	−.029	−.068*	−.038	−.059	−.098**	−.124**	.302***	.365***	.178***	.274***
Instructors' bias	—	—	—	—	—	—	.296***	.378***	.221***	.172***	.326***	−.060	−.070*	−.163***	−.099**
Classmates' bias	—	—	—	—	—	—	—	.711***	−.017	.406***	.441***	−.062	−.054	−.177***	−.113**
Friends' bias	—	—	—	—	—	—	—	—	.108**	.293***	.404***	−.044	−.026	−.135***	−.101**
Instructors' harass	—	—	—	—	—	—	—	—	—	−.032	.014	−.035	.000	−.058	−.036
Classmates' harass	—	—	—	—	—	—	—	—	—	—	.671***	−.097**	−.084*	−.229***	−.117**
Friends' harass	—	—	—	—	—	—	—	—	—	—	—	−.067*	−.094**	−.173***	−.133***
Family STEM	—	—	—	—	—	—	—	—	—	—	—	—	.450***	.675***	.375***
Friends STEM	—	—	—	—	—	—	—	—	—	—	—	—	—	.371***	.765***
Family college	—	—	—	—	—	—	—	—	—	—	—	—	—	—	.450***
Scale	1–4	1–6	1–6	1–6	1–6	1–6	1–6	1–6	1–6	1–6	1–6	1–6	1–6	1–6	1–6
M	3.23	4.95	4.56	3.59	5.44	1.95	1.63	1.82	2.75	1.19	1.31	4.90	4.62	5.37	5.01
SD	0.40	0.60	0.74	0.87	0.78	1.47	1.06	1.16	1.47	0.67	0.74	1.09	1.07	0.79	0.92

Note. $N = 685$. GPA = first-year grade point average; STEM = science, technology, engineering, and mathematics; STEM value = STEM value beliefs; STEM competence = STEM competence beliefs; STEM costs = perceived STEM costs; STEM career = STEM career aspirations; instructors' bias = STEM-gender bias from instructors (faculty, teaching assistants, or graduate students); classmates' bias = perceived classmates' STEM-gender bias; friends' bias = perceived friends' STEM-gender bias; instructors' harass = perceived sexual harassment from instructors (faculty, teaching assistants, or graduate students); classmates' harass = perceived sexual harassment from classmates; friends' harass = perceived sexual harassment from friends; family STEM = perceived support for STEM achievement among family; friends STEM = perceived support for STEM achievement among friends; family college = perceived support for college achievement among family; friends college = perceived support for college achievement among friends.

*$p < .05$. **$p < .01$. ***$p < .001$.

aspirations) were significantly and positively correlated with one another. However, STEM costs and value were not significantly related. The strongest associations were for STEM career aspirations in relation to STEM value and STEM competence beliefs. STEM value, competence beliefs, and costs were controlled for when testing predictors on STEM career aspirations.

Table 2 presents the descriptive statistics and bivariate correlations involving the humanities-related measures. Also, Table 3 summarizes the bivariate correlations among the STEM and the humanities motivation measures. There was missing data for humanities value ($n = 4$), humanities competence beliefs ($n = 4$), humanities costs ($n = 5$), and humanities non-STEM career aspirations ($n = 1$). The bivariate correlations were performed listwise, with the 679 participants having scores for all of these measures.

Percent of women experiencing discrimination within past year. The percentages of women experiencing different types of discrimination are summarized in Table 4. We further checked to see how often women reported experiencing any sexual harassment or STEM-related gender bias across all three sources. Only 21.9% of women reported having never experienced sexual harassment and 39.1% reported never having experienced STEM gender bias during the past year.

Group differences. We next conducted three preliminary multivariate analyses of variance (MANOVAs) to test whether there were any group differences in our predictor or outcome variables based on participants' membership in an UR ($n = 243$) versus non-underrepresented (non-UR; $n = 501$) ethnic-racial group (i.e., self-identified as Latinx/Hispanic, Black/African American, Native American, or Native Hawaiian).

In the first MANOVA, we entered the sexual harassment, STEM-related gender bias, and STEM support variables. There was a significant multivariate effect for UR status, $F(5, 733) = 3.654$, $p < .001$, $\eta^2 = .038$. Univariate tests revealed two significant differences. UR women reported more sexual harassment from classmates ($M = 1.247$, $SD = 0.806$) than did non-UR women ($M = 1.146$, $SD = 0.545$), $F(1, 742) = 34.131$, $p < .001$, $\eta^2 = .044$. Non-UR women reported higher family STEM support ($M = 5.001$, $SD = 1.038$) than did UR women ($M = 4.685$, $SD = 1.145$), $F(1, 742) = 34.131$, $p < .001$, $\eta^2 = .044$.

In the second MANOVA, we included the following outcome variables: first-year GPA, STEM value, STEM competence beliefs, STEM costs, and possible STEM career aspirations. There was a significant multivariate effect for women's UR status, $F(5, 733) = 4.052$, $p = .001$, $\eta^2 = .027$. Univariate tests revealed only one significant difference. Non-UR students had higher average first-year GPAs ($M = 3.287$, $SD = 0.390$) than did UR students ($M = 3.108$, $SD = 0.399$), $F(1, 742) = 34.131$, $p < .001$, $\eta^2 = .044$.

The third MANOVA included the following outcome variables: humanities value, humanities competence beliefs, humanities costs, and possible non-STEM career aspirations. Due to missing scores, the analysis included 679 participants ($n = 221$ UR; $n = 458$ non-UR). The multivariate effect for women's UR status was not significant, $F(4, 674) = 0.23$, $p = .924$.

Main Analyses

To test our hypothesized predictors of women's STEM motivation and career aspirations, we conducted separate hierarchical regressions with STEM value, STEM competence beliefs, STEM costs, and STEM career aspirations. All of the non-dichotomous variables were centered. In Step 1, we entered students' first-year GPAs to control for overall academic performance. In the same step, we also included UR status (0 = *no*, 1 = *yes*). When testing predictors of STEM career aspirations, we also included STEM value, competence beliefs, and costs in the first step. In the second step, we entered perceived STEM-related gender bias as well as experiences with sexual harassment from instructors (faculty, teaching assistants, or graduate students), classmates, and friends. In the third step, we entered perceived STEM encouragement from friends and family. Finally, for exploratory purposes, we entered a fourth step that included two-way interactions between UR status and each of the sexual harassment, STEM-related gender bias, and STEM encouragement variables. No hypotheses were advanced regarding the last step. Therefore, when testing our hypotheses, we focused on the results from the first three models.

In all analyses, there was no evidence of multicollinearity (all variance inflation factor [VIF] values <3), except when the two-way interactions with UR status were entered in the fourth step (all VIF values <5). Higher VIF values are not unusual when multiple interaction effects involve the same moderator (Field, 2013). The F values and R^2 change corresponding to the fourth step are indicated in the bottom note of each regression table. Unless indicated otherwise in the text below, the interaction effects did not significantly add to the model.

STEM value. As seen in Table 5, each of the first three steps added significantly to the model in the regression analysis with women's STEM value. The significant factors appearing in the final model included UR status (positive), instructors' gender bias (positive), classmates' gender bias (negative), instructors' sexual harassment (negative), and friends' STEM encouragement (positive). The final model accounted for 9.3% of the variance in STEM value. Each of these associations was in the hypothesized direction except for instructors' gender bias. That is, we expected a negative (rather than positive) association between STEM value and instructors' gender bias.

In the bivariate correlations, instructors' gender bias and STEM value variables were unrelated. To better understand the positive effect in the regression, we performed a series of follow-up analyses to see whether the effect was due to any

Table 2. Descriptive Statistics and Bivariate Spearman Correlations With Humanities Motivation and Non-STEM Career Aspiration Variables.

Variable	GPA	HUM Value	HUM Competence	HUM Costs	Non-STEM Career	Teachers' Bias	Classmates' Bias	Friends' Bias	Instructors' Harass	Classmates' Harass	Friends' Harass	Family STEM	Friends STEM	Family College	Friends College
GPA	—	.076*	.041	−.050	.003	−.003	−.025	−.017	−.041	−.060	−.069*	.033	−.022	−.012	−.062
HUM value	—	—	.390***	−.185***	.371***	.065*	−.022	.018	−.047	.056	.032	.025	.016	.078*	.070*
STEM competence	—	—	—	−.308***	.315***	−.005	−.016	.021	−.099**	.021	.022	.121**	.059	.184***	.147***
HUM costs	—	—	—	—	−.145***	.048	.098**	.071*	.020	.122**	.134***	−.094**	.053	−.114**	−.024
Non-STEM career	—	—	—	—	—	.077*	.088*	.070*	−.031	−.009	.033	−.052	−.083*	.052	.003
Instructors' bias	—	—	—	—	—	—	.297***	.378***	.218***	.175***	.326***	−.059	−.075*	−.163	−.103
Classmates' bias	—	—	—	—	—	—	—	.712***	−.015	.407***	.442***	−.060	−.050	−.176***	−.111**
Friends' bias	—	—	—	—	—	—	—	—	.105**	.294***	.404***	−.043	−.023	−.136***	−.100**
Instructors' harass	—	—	—	—	—	—	—	—	—	−.030	.013	−.037	−.006	−.059	−.043
Classmates' harass	—	—	—	—	—	—	—	—	—	—	.671***	−.099**	−.071*	−.235***	−.104**
Friends' harass	—	—	—	—	—	—	—	—	—	—	—	−.068*	−.090*	−.176***	−.129***
Family STEM	—	—	—	—	—	—	—	—	—	—	—	—	.454***	.674***	.379***
Friends STEM	—	—	—	—	—	—	—	—	—	—	—	—	—	.379***	.762***
Family college	—	—	—	—	—	—	—	—	—	—	—	—	—	—	.459***
Scale	1–4	1–6	1–6	1–6	1–6	1–6	1–6	1–6	1–6	1–6	1–6	1–6	1–6	1–6	1–6
M	3.23	4.95	4.56	3.59	5.44	1.95	1.63	1.82	2.75	1.19	1.31	4.90	4.62	5.37	5.01
SD	0.40	0.60	0.74	0.87	0.78	1.47	1.06	1.16	1.47	0.67	0.74	1.09	1.07	0.79	0.92

Note. $N = 679$. Six participants were missing one or more of the humanities motivation measures; the bivariate correlations were performed listwise with participants with missing values excluded ($N = 679$). GPA = first-year grade point average; STEM = science, technology, engineering, and mathematics; HUM value = humanities value beliefs; HUM competence = humanities competence beliefs; HUM costs = perceived humanities costs; non-STEM career = non-STEM career aspirations; instructors' bias = STEM-gender bias from instructors (faculty, teaching assistants, or graduate students); classmates' bias = perceived classmates' STEM-gender bias; friends' bias = perceived friends' STEM-gender bias; instructors' harass = perceived sexual harassment from instructors (faculty, teaching assistants, or graduate students); classmates' harass = perceived sexual harassment from classmates; friends' harass = perceived sexual harassment from friends; family STEM = perceived encouragement for STEM achievement among family; friends STEM = perceived encouragement for STEM achievement among friends; family college = perceived encouragement for college achievement among family; friends college = perceived encouragement for college achievement among friends.

*$p < .05$. **$p < .01$. ***$p < .001$.

Table 3. Bivariate Correlations Between STEM and Humanities/Non-STEM Variables.

Variable	Humanities Value	Humanities Competence Beliefs	Humanities Costs	Non-STEM Career Aspirations
STEM value	.572***	.329***	−.075*	.040
STEM competence beliefs	−.042	.167***	−.027	−.085*
STEM costs	.014	.001	.305***	.036
STEM career aspirations	−.094**	.111**	−.050	−.234***

Note. $N = 679$.
*$p < .05$. **$p < .01$. ***$p < .001$.

Table 4. Percent Reporting Discrimination Within Last Year by Frequency of Occurrence and Type.

Variable	Never (%)	1–2 Times (%)	3–6 Times (%)	6–12 Times (%)	13–24 Times (%)	24 or More Times (%)
Instructors' gender bias	61	14	8.3	7.4	4.4	4.8
Classmates' gender bias	65.1	17.8	9.2	5.3	1.8	0.9
Friends' gender bias	55.2	22.6	12	6.4	2.3	1.5
Instructors' sexual harassment	29.5	15.2	21.9	21.2	8.8	3.5
Classmates' sexual harassment	89.9	5.1	2.3	1.6	0.7	0.3
Friends' sexual harassment	79.9	13	4.5	1.6	0.7	0.3

Note. $N = 685$. Across all three sources, 39.1% of the women reported never experiencing any gender bias and 21.9% reported never experiencing any sexual harassment. Instructors = faculty, teaching assistants, and graduate students.

Table 5. Hierarchical Regression Analysis for STEM Value.

	Model 1			Model 2			Model 3		
Variable	*B*	*SE B*	β	*B*	*SE B*	β	*B*	*SE B*	β
GPA	.085	.057	.058	.070	.057	.048	.082	.055	.056
Underrepresented	.093	.049	.074	.100	.049	.079*	.103	.048	.082*
Instructors' bias				.036	.017	.089*	.041	.017	.103*
Classmates' bias				−.088	.032	−.157**	−.081	.031	−.146**
Friends' bias				.051	.029	.101	.047	.028	.093
Instructors' harassment				−.040	.016	−.099*	−.038	.015	−.096*
Classmates' harassment				−.024	.046	−.027	−.010	.046	−.011
Friends' harassment				−.041	.044	−.052	−.032	.042	−.040
Family STEM encourage							.032	.029	.059
Friends STEM encourage							.078	.033	.141*
Family college encourage							.003	.040	.005
Friends college encourage							.050	.039	.078
R^2_{change}	.007			.028			.057		
F_{change}	2.45			3.28**			10.64***		

Note. $N = 685$. Entering interaction effects between underrepresented status and each of the bias, harassment, and support variables in a fourth step did not significantly add to the model, $F_{\text{change}} = 0.84$, $p = .587$. GPA = grade point averages; STEM = science, technology, engineering, and mathematics; underrepresented = underrepresented racial-ethnic minority (0 = *no*, 1 = *yes*); bias = STEM-related gender bias; harassment = sexual harassment; encourage = encouragement; instructors = faculty, teaching assistants, and graduate students.
*$p < .05$. **$p < .01$. ***$p < .001$.

particular variable. We found the positive effect emerged only when the measures of sexual harassment were included in the regression models; when all of the sexual harassment measures were removed, the relation between instructors' STEM-related gender bias and STEM value was no longer significant.

STEM competence beliefs. Table 6 presents the results from the regression with women's competence beliefs (i.e., expectations for success) in STEM. The first and the third steps added significantly to the model. In the third step, the significant factors were first-year GPA (positive), friends' sexual harassment (negative), and friends' college encouragement (positive). This model accounted for 12.0% of the variance in STEM competence beliefs. Each association was in the predicted direction.

STEM costs. The results regarding the regression with perceived STEM costs appear in Table 7. Only the first two steps (i.e., not the third step) added to the model. The significant

Table 6. Hierarchical Regression Analysis for STEM Competence Beliefs.

	Model 1			Model 2			Model 3		
Variable	*B*	*SE B*	β	*B*	*SE B*	β	*B*	*SE B*	β
GPA	.367	.071	.199***	.355	.071	.192***	.374	.068	.203***
Underrepresented	.068	.061	.043	.068	.061	.043	.073	.060	.046
Instructors' bias				.022	.021	.044	.029	.021	.057
Classmates' bias				−.060	.040	−.085	−.052	.038	−.074
Friends' bias				.030	.036	.046	.027	.035	.042
Instructors' harassment				−.026	.020	−.052	−.023	.019	−.046
Classmates' harassment				.080	.058	.072	.097	.056	.087
Friends' harassment				−.118	.054	−.117*	−.104	.053	−.103*
Family STEM encourage							.064	.036	.094
Friends STEM encourage							.054	.041	.078
Family college encourage							−.020	.050	−.022
Friends college encourage							.128	.048	.159**
R^2_{change}	.038			.013			.069		
F_{change}	13.54***			1.57			13.08***		

Note. $N = 685$. Entering interaction effects between underrepresented status and each of the bias, harassment, and support variables in a fourth step did not significantly add to the model, $F_{change} = 0.95$, $p = .484$. GPA = grade point averages; STEM = science, technology, engineering, and mathematics; underrepresented = underrepresented racial-ethnic minority (0 = *no*, 1 = *yes*); bias = STEM-related gender bias; harass = sexual harassment; encourage = encouragement; instructors = faculty, teaching assistants, and graduate students.
*$p < .05$. **$p < .01$. ***$p < .001$.

Table 7. Hierarchical Regression Analysis for STEM Cost.

	Model 1			Model 2			Model 3		
Variable	*B*	*SE B*	β	*B*	*SE B*	β	*B*	*SE B*	β
GPA	−.325	.084	−.149***	−.311	.082	−.143***	−.324	.082	−.149***
Underrepresented	.084	.072	.045	.053	.070	.028	.054	.071	.029
Instructors' bias				.018	.025	.030	.017	.025	.028
Classmates' bias				.154	.046	.186***	.151	.046	.183**
Friends' bias				.017	.041	.023	.014	.041	.019
Instructors' harassment				−.003	.023	−.005	−.005	.023	−.009
Classmates' harassment				.064	.067	.049	.060	.067	.045
Friends' harassment				.026	.063	.022	.019	.063	.016
Family STEM encourage							−.032	.043	−.039
Friends STEM encourage							.042	.049	.051
Family college encourage							.028	.060	.025
Friends college encourage							−.128	.057	−.134*
R^2_{change}	.027			.063			.011		
F_{change}	9.46***			7.80***			2.01		

Note. $N = 685$. Entering interaction effects between underrepresented status and each of the bias, harassment, and support variables in a fourth step did not significantly add to the model, $F_{change} = 1.41$, $p = .172$. GPA = grade point averages; STEM = science, technology, engineering, and mathematics; underrepresented = underrepresented racial-ethnic minority (0 = *no*, 1 = *yes*); bias = STEM-related gender bias; harass = sexual harassment; encourage = encouragement; instructors = faculty, teaching assistants, and graduate students.
*$p < .05$. **$p < .01$. ***$p < .001$.

factors were first-year GPA (negative), classmates' gender bias (positive), and friends' college encouragement (negative), in expected directions. The first two steps accounted for 10.1% of the variance in STEM costs.

Possible STEM career aspirations. As seen in Table 8, each of the first three steps significantly added to the model predicting women's possible STEM career aspirations. In the third step, there were significant effects for STEM value, STEM competence beliefs, family's STEM encouragement, and friends' STEM encouragement. All were positively related to appraisals of a possible STEM career. In addition, family college encouragement was significant and with a negative association. In bivariate correlations, family college encouragement was positively related to STEM career aspirations; hence, the negative effect only emerged once STEM encouragement and the other variables were included in the model. The third model accounted for 34.5% of the variance in

Table 8. Hierarchical Regression Analysis for Possible STEM Career Aspirations.

Variable	Model 1			Model 2			Model 3		
	B	*SE B*	β	*B*	*SE B*	β	*B*	*SE B*	β
GPA	−.046	.067	−.023	−.053	.067	−.027	−.037	.064	−.019
Underrepresented	−.003	.056	−.002	.004	.057	.003	.039	.055	.024
STEM value	.328	.046	.247***	.319	.047	.239***	.259	.045	.194***
STEM competence beliefs	.413	.039	.390***	.414	.039	.391***	.364	.038	.344***
STEM cost	.013	.031	.014	.024	.032	.027	.027	.031	.030
Instructors' bias				−.010	.020	−.018	−.003	.019	−.005
Classmates' bias				.010	.037	.013	.002	.035	.003
Friends' bias				.004	.033	.006	−.001	.032	−.002
Instructors' harassment				−.012	.018	−.023	−.017	.018	−.031
Classmates' harassment				−.054	.054	−.046	−.048	.052	−.041
Friends' harassment				−.055	.051	−.052	−.054	.048	−.051
Family STEM encourage							.143	.033	.199***
Friends STEM encourage							.171	.038	.234***
Family college encourage							−.096	.046	−.098*
Friends college encourage							−.061	.044	−.071
R^2_{change}	.264			.008			.072		
F_{change}	44.82***			1.26			18.36***		

Note. $N = 685$. Entering interaction effects between underrepresented-minority status and each of the bias, harassment, and support variables in a fourth step significantly added to the model, $F_{\text{change}} = 2.18$, $p = .017$, $R^2_{\text{change}} = .021$. Two interaction effects were significant: Underrepresented Status × Classmates' Bias ($B = -.255$, $SE = .100$, $\beta = -.158$, $p = .011$) and Underrepresented Status × Family STEM Encouragement ($B = -.264$, $SE = .094$, $\beta = -.159$, $p = .005$). Follow-up tests indicated the association between classmates' gender bias and STEM career aspirations was positive for non-underrepresented students ($\beta = .096$, $p = .080$) and negative for underrepresented students ($\beta = -.156$, $p = .102$), although neither was significant. The association between family STEM encouragement and STEM career aspirations was positive and significant for non-underrepresented students ($\beta = .292$, $p < .001$) and was nonsignificant for underrepresented students ($\beta = .032$, $p = .706$). GPA = grade point averages; STEM = science, technology, engineering, and mathematics; underrepresented = underrepresented racial-ethnic minority (0 = *no*, 1 = *yes*); bias = STEM-related gender bias; harass = sexual harassment; encourage = encouragement; instructors = faculty, teaching assistants, and graduate students.
**p* < .05. ***p* < .01. ****p* < .001.

possible STEM career aspirations (with 5.8% due to the third step when STEM support was added).

In addition, entering the two-way interactions in a fourth step significantly accounted for another 2.1% of the variance (see note at bottom of Table 8 for information). The most notable finding was that family STEM encouragement predicted STEM career aspirations in non-UR women ($\beta = .292$, $p < .001$) but not UR women ($\beta = .032$, $p = .706$).

Humanities motivation and non-STEM career aspirations. To explore the extent that experiences with STEM-related gender bias and STEM support were particularly related to STEM motivation, we repeated the previous regression models by substituting measures of STEM value, competence beliefs, and costs with these for humanities. In addition, we replaced STEM career aspirations as an outcome variable with non-STEM career aspirations. These results are presented in the Online Supplemental Materials (http://journals.sagepub.com/doi/suppl/10.1177/0361684318806302) and are briefly summarized below.

First, humanities value was significantly related to first-year GPA (positive), instructors' STEM-related gender bias (positive), classmates' harassment (positive), and family college encouragement (positive). Second, humanities competence belief was significantly associated with instructors' sexual harassment (negative), friends' STEM encouragement (negative), family college encouragement (positive), and friends' college encouragement (positive). Third, humanities costs were associated with friends' STEM encouragement (positive) and family STEM encouragement (negative). Finally, non-STEM career aspirations were related to STEM value (positive), STEM competence beliefs (negative), family's STEM encouragement (negative), friends' STEM encouragement (negative), family's overall college encouragement (positive), and friends' overall college encouragement (positive).

The two-way interactions significantly added to the model with non-STEM career aspirations (for detail, see note at bottom of the table for this outcome in the Online Supplemental Materials). Among only non-UR women, non-STEM career aspirations were significantly related to instructors' STEM-related gender bias (positive) and family STEM encouragement (negative). However, among UR women, non-STEM career aspirations were not significantly related to instructors' gender bias or family STEM encouragement.

The results generally support the premise that experiences with STEM-related gender bias and STEM encouragement had domain-specific associations with motivation and career aspirations. STEM-related gender bias from classmates predicted greater humanities value, while higher STEM encouragement from friends (or from family for non-UR only) was related to lower humanities motivation or non-STEM career aspirations. At the same time, overall college encouragement from family or friends was positively associated with humanities motivation and non-STEM career interests.

Discussion

We investigated the predictive significance of sexual harassment, STEM-related gender bias, and STEM encouragement on STEM motivation and career aspirations among women in introductory biology courses for majors in the life sciences. Specifically, we examined the relation of these variables to students' competence and value beliefs in STEM, perceived costs in STEM, and appraisal of a possible STEM career. In each analysis, we controlled for students' first-year GPA. Our analyses revealed that experiences with sexual harassment and STEM-related gender bias occurred among most undergraduate women. We separately considered instructors (faculty, teaching assistants, or graduate students), classmates, and friends as sources. We observed that both types of discrimination uniquely contributed to lower STEM motivation. Furthermore, as expected, we found perceived STEM support from friends and family had significant positive associations with STEM motivation—after taking into account the experiences with discrimination, indicating how social context may hinder or help women's persistence in STEM. Finally, we found evidence that STEM-related bias and STEM encouragement had domain-specific effects when we separately analyzed motivation and career aspirations in STEM and non-STEM fields.

Prevalence of Gender Bias and Sexual Harassment

The majority of women in our sample reported experiencing STEM-related gender bias (60.9%) or sexual harassment (78.1%) at least once in the past year. When the source was taken into account, the incidence of STEM-related gender bias was similar for instructors, classmates, and friends (approximately 35–45% at least once for each source; see Table 4). A recent survey of undergraduate women in STEM majors at a U.S. university found similar occurrences of reported gender-biased STEM comments (Robnett, 2016).

In our sample, the incidence of reported sexual harassment perpetrated by instructors was appreciably higher (70% at least once) than from friends (20% at least once) or classmates (10% at least once). In the American Association of University Women's (2005) national survey of undergraduates in the United States, 62% of women indicated they had experienced some form of sexual harassment. Instructors, TAs, or graduate students were among the most commonly cited sources. Furthermore, a recent report (National Academies of Sciences, Engineering, and Medicine, 2018) cited surveys that found between one-fifth to one-half of undergraduate and graduate female science students experienced sexual harassment from faculty or staff at universities in the United States.

Some Instructors and Peers May Undermine STEM Motivation

In our analyses, we considered reported experiences with sexual harassment and STEM-related gender bias separately from instructors, classmates, and friends. We found that both sexual harassment and gender-STEM bias were related to women's motivation (after controlling for GPA). However, as discussed below, the source of the discrimination mattered.

Experiences with STEM-related gender bias. The reported incidences of gender-biased incidents in STEM were similar regarding friends, instructors, and classmates as sources. However, experiencing STEM-related gender bias from classmates (and not other sources) was negatively related to women's STEM value, and it was positively related to their perceived STEM costs. Furthermore, classmates' STEM-related gender bias was positively related to women's non-STEM career interest.

The views of classmates may be especially influential to women's motivation in STEM. Classmates may be seen as representative of the peers with whom women may expect to associate in the future as fellow students in the university or colleagues in the workplace. Thus, feeling accepted from one's classmates may be especially important for students from backgrounds not typically represented in a field, such as women in many STEM occupations (Cheryan et al., 2017; Dasgupta & Stout, 2014). As a consequence, experiencing classmates' sexist messages about women in STEM may lead many women to lose confidence and interest in STEM (e.g., Brown & Leaper, 2010; Riegle-Crumb & Morton, 2017). Over time, women with these experiences may view a future in STEM as having more costs than benefits (Dasgupta & Stout, 2014).

Although experiencing STEM-related gender bias from instructors was not significantly related to STEM motivation, there was a significant effect on humanities motivation. STEM-related gender bias from instructors was positively related to humanities value. Perhaps these sexist experiences in STEM lead some women to increase their interest in other fields, such as those in the humanities (Cheryan et al., 2017).

One result in the regression analyses ran counter to what was expected. Teacher gender bias was positively associated with STEM value in the regression model, although these variables were unrelated in the bivariate correlations. Follow-up tests revealed the association was only significant in the regression when sexual harassment was included in the model. Future research is needed to explore this apparent suppression effect.

Experiences with sexual harassment. Sexual harassment was another significant predictor of women's STEM motivation.

Of particular note, sexual harassment from instructors was negatively related to STEM value and to humanities competence beliefs. The reason that sexual harassment from instructors was specifically associated with STEM value may be due to several factors. First, sexual harassment (e.g., unwanted or inappropriate sexual behaviors) may be more easily recognized in instructors, given their status and power (Brown & Bigler, 2005). Also, teacher-perpetrated sexual harassment may have an especially pernicious impact on academic motivation, given the power and authority they have over students (Gruber & Fineran, 2016; Huerta, Cortina, Pang, Torges, & Magley, 2006; Rosenthal et al., 2016). Moreover, sexual harassment from persons of authority may foster feelings of institutional betrayal (Rosenthal et al., 2016; Smith & Freyd, 2014). Thus, when these experiences occur within one's major, they may undermine interest in the field. Furthermore, because experiences with sexual harassment from instructors might be associated with the overall academic climate at a university, one's self-confidence regarding other subjects (such as humanities) may also be affected. In this regard, the results suggest that sexual harassment from instructors may have an impact on academic motivation in general, whereas STEM-related gender bias may affect academic motivation more specifically in STEM.

Sexual harassment from peers also predicted women's motivation. First, women who reported sexual harassment from friends indicated lower STEM competence beliefs. Also, those who experienced sexual harassment from classmates tended to express higher value for humanities. In sum, sexual harassment from peers or instructors may have undermined women's interest and confidence in STEM while making non-STEM options (such as humanities) more attractive. However, we do not know from these analyses whether women associated sexual harassment with STEM (vs. university life as a whole).

Some Friends and Family May Bolster STEM Motivation

Perceived encouragement from friends and family for STEM and for college overall constituted the last set of predictors in our model. In the bivariate correlations, each source of support was positively related to STEM motivation. We hypothesized that STEM encouragement variables would independently predict women's STEM motivation after controlling for students' GPA, experiences with STEM-related gender bias, and sexual harassment. In addition, when testing STEM career aspirations, we controlled for STEM motivation (competence beliefs, value, and costs). The regression analyses lent support to our predictions. However, perceived STEM encouragement from friends was associated with more STEM motivation outcomes than was STEM encouragement from family. Specifically, friends' STEM encouragement was positively related to STEM value beliefs and STEM career aspirations. Family members' STEM encouragement was only associated with STEM career aspirations. Finally, the STEM outcome measures were most consistently and positively related to encouragement for STEM rather than encouragement for college. Conversely, the non-STEM outcome measures were positively related to encouragement for college and negatively related (or unrelated) to encouragement for STEM. The latter set of results supports our premise that domain-specific support is important.

In college, feeling the support of one's friends may help to validate and reinforce women's STEM identity and motivation (Rice, Barth, Guadagno, Smith, & McCallum, 2013). Our findings from the regression analyses suggest that perceived STEM encouragement (especially from friends) may help to strengthen STEM motivation even after accounting for the deleterious effects of gender bias and sexual harassment. A recent study of college STEM majors similarly found that friends' support mitigated the negative effects of STEM-related gender bias (Robnett, 2016). Our study further suggests that friends' support for STEM may help to counter the negative effects of sexual harassment as well as STEM bias. Friends' encouragement of STEM may be especially helpful in maintaining STEM motivation during college when students are balancing social needs with academic success.

Perceived STEM encouragement from family was unrelated to STEM motivation, but it was significantly associated with higher STEM career aspirations. When considering a future career in STEM, perhaps family support for STEM provides some women with an added sense of security that bolsters their career aspirations (e.g., Ferry, Fouad, & Smith, 2000). This idea requires testing in future research.

Underrepresented Status as Moderator

In our analyses, we tested students' UR status as a factor or moderator in the analyses. These analyses were exploratory and no hypotheses were advanced. Preliminary comparisons revealed higher average experiences with sexual harassment perpetrated by classmates among UR students when compared to non-UR students. Both sets of findings suggest how women of color who are UR in STEM may face particular hurdles more their non-UR classmates (e.g., McGee & Bentley, 2017; Remedios & Snyder, 2015).

We also found higher average family STEM encouragement among non-UR women than UR women. Also, UR status significantly moderated the relation of family STEM encouragement to women's career aspirations. Among non-UR students, family STEM encouragement was a significant predictor of STEM career aspirations (positive association) and non-STEM career aspirations (negative association). Among UR students, however, family STEM encouragement was not significantly related to aspirations in either STEM or non-STEM careers. One tentative interpretation might be that family STEM encouragement was less important among UR women when evaluating career options. Because the interaction effect was not hypothesized, this finding should be viewed cautiously. To further test this possible pattern in future research, parents' education should be taken into account as it might moderate parents' influence on their offspring's career aspirations (Holmes, Gore, Smith, & Lloyd, 2018).

Limitations and Future Directions

We note some limitations in our study and suggest corresponding directions for new research. First, our study was correlational; therefore, no conclusions about causality can be drawn. A longitudinal study conducted over the course of students' college years would allow researchers to infer whether the amounts of discrimination experienced by women predicted later changes in STEM motivation (e.g., see McKellar et al., 2018; Wang, 2012, for longitudinal studies testing middle or high school classroom characteristics in relation to students' later motivation).

Second, in the current research study, we asked participants to report how often they had experienced sexual harassment and STEM-related gender bias after broadly describing each of these forms of discrimination. Past research among adolescent girls found that labeling sexual harassment explicitly may lead to underreporting (Witkowska & Gådin, 2005). This may happen because women do not want to view or label themselves as a victim (Crosby, 1984). In future research, participants could be asked how often they experienced particular types of behaviors (e.g., unwanted sexual comments, demeaning comments about women's intelligence in STEM) without labeling them explicitly as sexual harassment or gender bias. This would also give information on how often specific types of gender bias and harassment behaviors were experienced as well as whether some specific behaviors might have more impact than others.

Third, we would favor considering a greater variety of potential perpetrators of sexism or potential sources of encouragement. To limit the length of our survey, we did not consider some characteristics about possible sources that might be pertinent to explore in future studies. This would include distinguishing among faculty, teaching assistants, and graduate students as sources of sexism. Different kinds of instructors may have different influences on undergraduate women. Graduate students and teaching assistants are often close to undergraduates in age, and they might be viewed more as peers. In contrast, faculty members are typically much older than undergraduates and may be more readily perceived as authority figures. Each source may be experienced as forms of betrayal, but perhaps more strongly regarding faculty than teaching assistants or graduate students (Weiss & Lalonde, 2001).

In addition, it would be revealing to know more about the perceived sources of encouragement for STEM. We asked only about family and friends. We did not differentiate among which family members or the types of friends. Nor did we consider other potentially important sources of support, such as instructors. Prior work has highlighted the positive impact of faculty mentors on women's STEM motivation (e.g., Downing, Crosby, & Blake-Beard, 2005).

Related to considering characteristics of the sources of influence, we recommend taking into account the gender and academic major of peers and instructors. The impact of gender bias or sexual harassment on students may partly depend on whether the perpetrator is an ingroup or outgroup member. For example, experiencing gender bias from a same-gender peer in STEM (vs. a different-gender peer or one outside of STEM) may be especially threatening to one's sense of STEM belonging because they may be viewed as ingroup members (Leaper, 2015).

A fourth area to consider in future research is the number of persons from whom individuals experienced discrimination or encouragement. Our measures only asked how often women had these experiences in the past year. It might be revealing to know the number of friends, classmates, or instructors who were unsupportive or supportive. Perhaps a stronger impact on motivation will be seen when several instructors or several friends signal negative or positive attitudes about women in STEM.

Our fifth recommendation is to broaden the measure of perceived costs. The measure of perceived costs used in the present study (Kosovich et al., 2015, based on Eccles & Wigfield, 1995) focuses on the amount of time needed to succeed. A more revealing assessment would consider a more nuanced set of possible costs. For example, when contemplating costs some students may consider issues related to expectations of discrimination (e.g., Fernández, Castro, Otero, Foltz, & Lorenzo, 2006), anticipated work-life balance (e.g., Myers & Major, 2017), and the perceived communal opportunities associated with careers (e.g., Evans & Diekman, 2009).

Sixth, a more complex model could test individual factors that might moderate or mediate the impact of discrimination on women's STEM motivation. For example, women who strongly identify with STEM (e.g., Kuchynka et al., 2018) or who are aware of gender bias (e.g., Pietri, Johnson, Ozgumus, & Young, 2018) may be more resistant to the effects of STEM-related gender bias. In turn, identifying influential individual factors that moderate the impact of discrimination can guide the design of intervention programs to promote women's STEM success (e.g., Pietri et al., 2018; Walton, Logel, Peach, Spencer, & Zanna, 2015). Additionally, it would be interesting to explore whether sense of belonging mediates the relation between gender bias and sexual harassment and STEM motivation. Similarly, future studies might explore whether sense of belonging mediates the relationship between STEM encouragement and STEM motivation.

Finally, we hope researchers will consider the relations of discrimination and encouragement to students' motivation and achievement in specific STEM fields. We looked at women enrolled in gateway biology courses required for biology and some other STEM majors. However, women are most underrepresented in STEM fields such as physics, computer science, and engineering (National Science Foundation, 2017), which may not have been highly represented in our sample. It would be helpful to learn the extent that experiences with discrimination and support may be partly related to these differential gender gaps. Another potential research question is to consider whether experiences with discrimination affect women differently when they are in strongly male-majority fields (such as the physical sciences or engineering) versus strongly female-majority fields (such as some of the humanities or social sciences; e.g., Steele, James, & Barnett, 2002). In an analogous manner, men may experience discrimination when they pursue feminine-stereotyped fields (e.g., Lagaert, Van Houtte, & Roose, 2017; Leaper & Van, 2008; Moss-Racusin, 2014).

Practice Implications

Our research suggests that instructors, peers, and family can hinder or bolster women's motivation and aspirations in STEM. Sexual harassment and gender biases are still barriers for many undergraduate women in introductory STEM courses. It is striking that 70% of women reported experiencing at least one instance of STEM-related gender bias, and 83% of women reported at least one instance of sexual harassment. These experiences were negatively related to their STEM motivation and aspirations. Of note, instructors' sexual harassment and classmates' gender bias had the most pronounced effects in the results. We suspect many women in STEM fields may be unaware of the prevalence of these behaviors. Educating girls and women about gender discrimination in STEM may help to increase awareness and to allow women to attribute difficulties to others rather than blaming themselves (e.g., Pietri et al., 2017; Weisgram & Bigler, 2007). At the same time, students of all genders need to be educated about gender bias and sexual harassment and their effects on students (e.g., Moss-Racusin, Pietri, et al., 2018). It is critical for university faculty and administrators to become aware of how these forms of gender-based discrimination may undermine women's STEM motivation and to take steps to overcome them. Moreover, it may be necessary to especially target male STEM faculty to increase their awareness and sensitivity to issues of gender bias (Handley, Brown, Moss-Racusin, & Smith, 2015).

Perceiving friends as encouraging them in STEM was positively related to women's STEM motivation and career aspirations, even after taking into account experiences with discrimination. Family STEM support was additionally predictive of women's appraisals of a possible STEM career. These findings point to the need to continue to provide support for women in STEM groups on campuses (e.g., Women in Science and Engineering) where women can foster a sense of belonging and identity in STEM. In addition, forming alliances with supportive male students may be a valuable way to encourage inclusion and benefit women as well as men (Walton et al., 2015). Finally, efforts to promote family members' support of girls' and young women's STEM motivation may further bolster motivation (e.g., Harackiewicz, Rozek, Hulleman, & Hyde, 2012).

Conclusions

Our study highlighted how perceived encouragement and experiences with discrimination may strengthen or weaken women's motivation and aspirations in STEM, respectively. To our knowledge, no prior published studies tested the effects of both sexual harassment and STEM-based gender bias on women's STEM motivation. Our results indicated both types of discrimination independently predicted motivation and aspirations. Moreover, the type of perpetrator mattered. Finally, we found evidence of domain-specific effects whereby STEM-based gender bias was negatively related to STEM outcomes but was unrelated (or positively related) to non-STEM outcomes. Also, STEM encouragement (rather than overall college encouragement) was most reliably associated with STEM outcomes. These findings are compatible with theoretical models of resilience that emphasize the combined impacts of protective factors (such as STEM support) and risks (such as gender bias and sexual harassment) on developmental outcomes (e.g., Masten, 2001). By identifying sources that impede or help, policy makers and administrators can develop and implement interventions aimed to foster the STEM motivation of all children and adults (also see Cheryan et al., 2017; Dasgupta & Stout, 2014; Diekman & Fuesting, 2018; Eccles & Wang, 2016, for additional factors to consider). As a society, we may thereby increase overall gender equality and promote the potential of all individuals.

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