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Robnett, Rachael

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**THE ROLE OF PEER SUPPORT FOR GIRLS AND WOMEN
IN THE STEM PIPELINE: PROMOTING IDENTIFICATION WITH STEM
AND MITIGATING THE NEGATIVE EFFECTS OF SEXISM**

A dissertation submitted in partial satisfaction
of the requirements for the degree of

DOCTOR OF PHILOSOPHY

in

PSYCHOLOGY

by

Rachael D. Robnett

June 2013

The Dissertation of Rachael D. Robnett
is approved:

Professor Campbell Leaper, chair

Professor Margarita Azmitia

Professor Faye Crosby

Tyrus Miller
Vice Provost and Dean of Graduate Studies

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Abstract

The Role of Peer Support for Girls and Women in the STEM Pipeline: Promoting Identification with STEM and Mitigating the Negative Effects of Sexism

Rachael D. Robnett

The present study examined the role peers play for girls and women in fields related to science, technology, engineering, and math (STEM). One set of analyses tested a mediational model in which features of the STEM peer climate predicted girls' and women's identification with STEM, which in turn predicted their intent to remain in STEM. Another set of analyses examined the prevalence of sexism in STEM and assessed whether peer support might be especially beneficial for girls and women who have experienced sexism. Across all analyses, particular attention was paid to differences that were driven by participants' phase of education. The sample included STEM-oriented girls and women in high school ($n = 134$), college ($n = 125$), and graduate school ($n = 102$) who completed a survey online or in person. Analyses carried out with path analysis generally supported the hypothesized mediational model. Also, in partial support of hypotheses, women who were pursuing STEM undergraduate majors reported experiencing more sexism than did their counterparts in high school and graduate school. Lastly, as hypothesized, the association between peer support and the intent to remain in STEM was especially strong among girls and women who had experienced sexism. Discussion highlights both theoretical and applied implications.

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**The Role of Peer Support for Girls and Women in the STEM Pipeline:
Promoting Identification with STEM and Mitigating the
Negative Effects of Sexism**

National trends within the United States indicate that individuals with the desire and training to obtain careers in fields related to science, technology, engineering, and math (STEM) are becoming less and less common. Central to this issue is the lack of diversity that currently characterizes many STEM fields. Specifically, women and members of some ethnic minority groups are especially unlikely to pursue STEM careers (AAUW, 2008, 2010; Aschbacher, Li, & Roth, 2010; Chemers, Zurbriggen, Syed, Goza, & Bearman, 2011; NSF, 2012). As such, policymakers, educators, and psychologists have argued that enhancing diversity in STEM is a desirable goal that could lead to many positive outcomes. For example, obtaining a broader array of perspectives would likely enhance STEM innovation and progress, which is advantageous in itself and from an economic standpoint (Handelsman et al., 2004, 2005; Jaggar, 1983; Zakaria, 2011). Moreover, jobs in STEM fields tend to be lucrative and prestigious; hence, greater diversity in STEM could help to combat structural-level inequities in social groups' status and power (Halpern et al., 2007). Collectively, these factors make it clear that understanding what leads people toward and away from careers in STEM is a worthwhile objective.

The present study assessed the role that peers in STEM play in girls' and women's pursuit of STEM careers. Although past research has established that features of the STEM peer climate can promote as well as detract from

underrepresented students' interest and retention in STEM (e.g., Riegle-Crumb, Farkas, and Muller, 2006; Stake & Nickens, 2005), less is known about constructs that underlie or alter peer influences (e.g., Brechwald & Prinstein, 2011). Thus, the first aim of the present study was to test a mediational model in which features of the STEM peer climate predict the strength of girls' and women's identification with STEM, which then predicts girls' and women's intent to remain in STEM (see Figure 1). The present study also examined the prevalence of sexism in STEM and whether having supportive peers in STEM is more important for girls and women who have experienced academic sexism than it is for girls and women who have not. The conceptual basis for examining each of these questions is detailed below.

Finally, an underlying theme in the present study is a phenomenon known as the *leaky pipeline*, whereby girls and women become less well represented in STEM at increasingly high phases of education. For example, in the field of chemistry, women currently earn over half of all bachelor's degrees, but this percentage drops to one-third at the doctoral level (NSF, 2012). To shed more light on this issue, the present study used a cross-sectional design to examine the role the STEM peer climate plays for girls and women in high school, college, and graduate school.

STEM Identification as a Mediator of Peer Influences

Prior Research on Peer Influences in STEM

Research indicates that students' academic achievement and goals can be shaped by their peers (e.g., Azmitia & Cooper, 2001; Kindermann, 2007). Some of this work suggests that peers play a role in steering girls and women away from

STEM. For example, at the high school level, girls tend to rate peers as being less supportive of their interest in STEM than do boys (Robnett & Leaper, in press; Stake & Nickens, 2005). Furthermore, some boys appear to hold negative views of girls and women who excel in STEM (Kessels, 2005; Stake, 2003); these attitudes appear to be especially prevalent among boys with low self-confidence in their own STEM abilities (Stake, 2003).

Women in STEM undergraduate majors and STEM graduate programs also report receiving low levels of support from their peers in STEM. In particular, feelings of social isolation are a frequently cited challenge (Herzig, 2002; Margolis, Fisher, & Miller, 2000; Zeldin & Pajares, 2000). For example, in a study of computer science majors, Margolis and colleagues (2000) found that social isolation led many women to believe that they were the only ones struggling with their coursework. As a result, many left the major to pursue different fields of study, which led the authors to argue that forming close, supportive bonds with other computer science students may be a vital component of women's retention in the field.

It is troubling that girls and women in STEM perceive a lack of peer support because several studies have illustrated the positive implications that peer support can have when it exists. For example, Rieggle-Crumb and colleagues (2006) found that girls with high-achieving female friends who outperformed them academically were more likely to take advanced STEM courses than were other girls (see also Crosnoe et al., 2008). The benefits of peer support were also highlighted in study conducted by Zeldin and Pajares (2000). In this retrospective study, women discussed factors that

had facilitated their progress toward high-level STEM careers, and peer support of STEM achievement was a factor that several women emphasized.

In sum, past research has established that there is a link between peer influences and girls' and women's interest, achievement, and retention in STEM (Herzig, 2002; Margolis et al., 2000; Rieggle-Crumb et al., 2006; Robnett & Leaper, in press; Stake & Nickens, 2005; Zeldin & Pajares, 2000). The present study sought to build on this body of research by examining *why* peers matter. From a theoretical standpoint, there is good reason to believe that peers are important because they influence the extent to which girls and women identify with STEM. Thus, in the next section, I explain why STEM identification is important and why it might be difficult to develop for girls and women in STEM. I then build a rationale for testing a model in which affordances from the STEM peer climate predict girls' and women's STEM identification, which in turn enhances girls' and women's STEM career commitment.

STEM Identification and Gender-Related Barriers

Theorists have long noted that forging an occupational identity is an important developmental milestone. For example, Arnett (2004) argued that deciding between potential career paths is a key feature of adolescence and emerging adulthood (see also Cooper, 2011; Erikson, 1968; Grotevant & Cooper, 1986). This work implies that settling on a specific career path was probably a salient goal for most of the participants in the present study.

In its most basic form, occupational identity can be conceptualized as identification with a specific career (e.g., pediatrician) or academic domain (e.g.,

psychology). In the present study, I focused on girls' and women's identification with STEM. This construct has been defined in distinct, yet largely complementary ways across fields such as developmental psychology, social psychology, and education (see Syed, Azmitia, & Cooper, 2011). Central to these definitions is the notion that STEM identification reflects the extent to which students view themselves as members of STEM-related communities of practice (Aschbacher et al., 2010). Brickhouse and Potter (2001) further note that STEM identification is informed by students' own perceptions of who they are and who they want to become with respect to STEM. Put differently, students high in STEM identification feel like they belong in STEM and have incorporated this sentiment into their current and future self-views.

Recent research has shown that STEM identification is predictive of positive outcomes such as expected and actual persistence in the STEM pipeline (Aschbacher et al., 2010; Chemers et al., 2011; Estrada, Woodcock, Hernandez, & Schultz, 2010). It is therefore noteworthy that identifying with STEM appears to be somewhat more challenging for girls and women than it is for boys and men (e.g., London, Rosenthal, Levy, & Lobel, 2011; Settles, Jellison, Pratt-Hyatt, 2009). Hence, attaining a better understanding of (a) barriers to girls' and women's STEM identification and (b) how to combat these barriers would likely promote greater gender equity in STEM.

One of the main barriers to girls' and women's STEM identification is related to conflicting identities. Specifically, some girls and women in STEM perceive an incompatibility between their gender and their pursuit of STEM careers (London et

al., 2011; Rosenthal, London, Levy, & Lobel, 2011; Settles et al., 2009). This phenomenon, which Settles (2004) refers to as *identity interference*, has been linked to negative outcomes for girls and women in STEM. For example, in a study of women who were pursuing STEM majors, Settles (2004) found that experiencing identity interference predicted lower performance in STEM classes and lower general wellbeing (see also London et al., 2011). These findings were replicated in a longitudinal study that included women in STEM majors as well as women in STEM graduate programs (Settles et al., 2009).

Further evidence of challenges associated with identity interference can be found in the stereotype threat literature. Specifically, when negative stereotypes about girls' and women's STEM abilities are chronically salient, some girls and women may cope by disidentifying with the STEM domain that they are pursuing (Good, Rattan, & Dweck, 2012; Spencer, C. Steele, & Quinn, 1999; J. Steele, 2003). In other words, even if girls and women do not believe that their gender is incompatible with success in STEM, being reminded that others *do* endorse this stereotype can nonetheless reduce the strength of their STEM identification.

Peer Climate Affordances as a Means of Promoting STEM Identification

It should be clear from the prior review that identity-related challenges have the potential to hinder girls' and women's pursuit of STEM careers. However, theory and research that focus on the construct of social identity suggest that establishing close, supportive ties to peers in STEM may buffer these challenges. Put simply, this is because there is a deep, well established connection between individuals' social

relationships and the factors that they incorporate into their self-views (Ashmore, Deaux, & McLaughlin-Volpe, 2004; Phinney, 2008; Tajfel & Turner, 1986).

Accordingly, having a supportive peer network that emphasizes STEM achievement should enhance the extent to which girls and women identify with STEM.

Research guided by social identity theory (Tajfel & Turner, 1986) and related perspectives (see Ashmore et al., 2004) provides empirical support for the prediction that peers in STEM can influence girls' and women's STEM identification. For example, Walton and Cohen (2007) conducted an experimental study in which undergraduates were made to feel either secure or insecure about the number of friends they had in their major. Results demonstrated that experimentally induced insecurity led to a drop in African American participants' sense of belonging in their major and in their general academic identification. Building on these findings, Walton and his colleagues conducted a series of studies in which they manipulated undergraduates' sense of social belongingness in academic domains (Walton, Cohen, Cwir, & Spencer, 2012). They found that even the most minor social connections, such as believing that one shares a birthday with a math major, led to heightened persistence on a math puzzle and a greater sense of connectedness to the field of math (see also Cohen & Garcia, 2008).

Several studies have also drawn connections between social ties and girls and women's STEM identification. For instance, one study showed that a low level of connectedness to peers in STEM was related to lower motivation and expected persistence in STEM among women in an undergraduate calculus class (Good et al.,

2012). Moreover, others have suggested that peer connections may enhance girls' and women's confidence about their place in STEM by reducing the threat that is caused by social isolation (e.g., Herzig, 2002; Margolis et al., 2000).

In summary, the STEM peer climate appears to have implications for girls' and women's confidence (Herzig, 2002), motivation (Good et al., 2012; Walton & Cohen, 2007), and sense of belongingness (Walton & Cohen, 2007) in STEM.

According to social identity theory and related perspectives, these constructs should predict the extent to which girls and women identify with STEM. Thus, in the hypothesized mediational model (see Figure 1), affordances from the STEM peer climate (i.e., confidence, motivation, and belongingness) were expected to predict girls' and women's STEM identification. In turn, girls' and women's STEM identification was expected to predict their intent to remain in STEM.

Differences driven by phase of education. I expected that the hypothesized model would be supported among girls and women at all three phases of education. This is, the model was expected to “work” for participants in high school, college, and graduate school. However, there are several reasons to believe that the associations among the constructs in the model would differ in strength depending on participants' phase of education. First, graduate departments are microcosms with their own norms, expectations, and idiosyncrasies, which is not likely to be the case in most STEM majors and STEM high school classes (Fox, 2000). Thus, I expected that the link between features of the STEM peer climate and STEM identification would be strongest among women in STEM graduate programs. In addition, I

expected that the link between STEM identification and the intent to remain in STEM would become increasingly strong with increased progress through the educational pipeline. In making this prediction, I drew from research demonstrating that academic identity and career plans become more closely fused as education progresses (Estrada et al., 2010).

Experiences with Sexism and Peer Support

A second goal of the present study was to examine girls' and women's experiences with sexism in STEM. Below, I provide an overview prior research in this domain. I then explain why having a supportive network of peers in STEM may be an important resource for girls and women who have experienced sexism. Finally, I highlight potential differences in the prevalence of sexism as a function of phase of education.

Prior Research on Sexism and Coping

Investigations of sexism in STEM are somewhat uncommon, particularly at the high school level. One exception is a study conducted by Leaper and Brown (2008), who found that over half of the adolescent girls in their sample had experienced academic sexism over the course of the past year. Parallel findings have been obtained among women in STEM undergraduate majors and STEM graduate programs. For example, women in STEM majors report experiencing greater levels of sexism than do women in non-STEM majors (J. Steele, James, & Barnett, 2002). Furthermore, there is evidence that women in STEM graduate programs are sometimes excluded and ignored by their male peers and faculty in the department

(Etzkowitz, Kemlgor, & Uzzi, 2000). Self-report findings such as these are corroborated by a recent experimental study that revealed the prevalence of sexist ideologies among professors in STEM departments (Moss-Racusin, Dovidio, Brescoll, Graham, & Handelsman, 2012).

A small amount of research suggests that sexism primarily comes from male peers in STEM (Leaper & Brown, 2008). However, other studies show that sexism can come from other sources as well. For instance, science and math teachers tend to call on boys and men more often than girls and women, ask boys and men more questions, and require more elaborative answers from boys and men (see Halpern et al., 2007). Thus, the present study assessed girls' and women's experiences with sexism from STEM peers as well as STEM teachers/professors, mentors, and advisors.

Unsurprisingly, girls and women who experience sexism in STEM experience negative outcomes such as lower STEM efficacy and engagement (Brown & Leaper, 2010; Settles, Cortina, Malley, & Stewart, 2006; J. Steele et al., 2002). Hence, factors that can mitigate sexism's negative effects merit examination. The coping literature indicates that social support could be a useful resource for girls and women who experience sexism in STEM (Lazarus & Folkman, 1984). Indeed, seeking social support has been conceptualized as an effective coping response for girls and women who experience general sexism (e.g., Foster, 2000; Leaper & Arias, 2010) and sexism in specific academic domains such as STEM (e.g., London et al., 2011). For this reason, I expected that having a supportive STEM peer network would be especially

critical for participants who have experienced sexism. Although I did not directly examine participants' use of social support as a coping response, I inferred that having a supportive peer network would provide participants with access to social support after encountering sexism.

Differences driven by phase of education. Systematic comparisons of girls' and women's experiences with sexism in STEM at different phases of education are rare. However, several scholars have speculated that the leaky pipeline phenomenon can be partially attributed to increases in the amount of sexism that girls and women face as they move through the pipeline (e.g., Etzkowitz et al., 2000; Herzig, 2002). In addition, Leaper and Brown (2008) suggested that the ability to perceive sexism may improve with age, which is closely associated with phase of education. Therefore, it seems plausible that sexism becomes an increasingly serious barrier as girls and women progress through the pipeline. This could be the case both because sexism becomes more prevalent and because girls and women become more adept at recognizing sexism as they age. As such, I hypothesized that women in graduate school would perceive the most sexism, followed by women in college and girls in high school. With respect to the hypothesized interaction between peer support and experiences with sexism, I anticipated that peer support would be helpful to girls and women who experience sexism regardless of their phase of education.

The Present Study

The present study had two broad goals. The first of these goals was to test the mediational model depicted in Figure 1. Specifically, Hypothesis 1 was that

affordances from the STEM peer climate (i.e., belongingness, motivation, and confidence) would predict participants' STEM identification, which in turn would predict participants' intent to remain in STEM. The hypothesized model was tested among girls and women in high school, college, and graduate school, and it was expected to fit well regardless of phase of education. However, phase of education was expected to moderate several paths in the model. Specifically, Hypothesis 2a was that the links between peer climate affordances and STEM identification would be stronger for participants in graduate school than other participants. Hypothesis 2b was that the links between STEM identification and the intent to remain in STEM would be stronger for women in graduate school than for women in college, and stronger for women in college than for girls in high school.

The second goal of the present study was to shed light on girls' and women's experiences with sexism in STEM. There is reason to believe that sexism becomes more common with increased progress through the STEM pipeline, but this premise has not been systematically tested. Thus, Hypothesis 3 predicted that women in STEM graduate programs would experience the most sexism, followed by women in STEM majors, and then girls in STEM high school classes. The present study also aimed to examine whether having a supportive network of peers in STEM might be especially important for girls and women who have experienced sexism. Hence, Hypothesis 4 predicted that experiences with sexism would moderate the association between peer support and the intent to remain in STEM, such that this link would be stronger for girls and women who have experienced sexism than for girls and women

who have not. The hypothesized interaction effect was not expected to be moderated by phase of education.

Method

Participants

Participants were recruited from three points in the educational pipeline. Specifically, the sample included STEM-oriented high school girls, women in STEM undergraduate majors, and women in STEM graduate programs. Each of these groups is described in more detail below.

High school. Girls were recruited from math and science classes at three high schools in northern and central California. As an incentive, participants were entered into a raffle to win one of several \$50 gift certificates. Preliminary analyses indicated that the three schools differed in their ethnic breakdown: Participants from one school were predominantly Asian American, whereas participants from the other two schools were predominantly European American. These findings are explained in full later.

In total, 400 girls participated. However, analyses for the present study focused on a subset of girls who were in at least 10th grade, which reduced the sample by 18% ($n = 330$). This was done to enhance the likelihood that participants had spent time thinking about their academic and career goals. In addition, participants were asked about the types of careers they would like to pursue in the future and, given the purpose of the present study, only girls who were at least moderately interested in pursuing a STEM career were included in the analyses. This reduced the sample by 41% ($n = 134$). Of the girls who were interested in a STEM career, 80% were interested in a career related to science, whereas 20% were interested in a career related to technology, engineering, or math. In sum, the final sample included 134

STEM-oriented high school girls who were in 10th through 12th grade. Their mean age was 16.52 years ($SD = .96$, range = 14 to 18). The majority of participants reported that their parents had obtained at least a 4-year degree. Specifically, 75% percent of mothers and 84% of fathers had received a bachelor's or graduate degree. With respect to ethnic background, participants identified as East Asian (53%), South Asian (29%), White (18%), Latina (2%), and Middle Eastern (2%), and Other (2%).

Undergraduate. Women at a northern California university were recruited through emails, course announcements, and flyers. As an incentive, participants were entered into a raffle to win one of several \$50 gift certificates. To be included in the present study, participants needed to be majoring (or pre-majoring) in a field related to STEM. The majority of participants (66%) were pursuing a degree in science, followed by technology/computer science (16%), engineering (12%), and math (6%). In total, 125 women participated. Their mean age was 20.28 years ($SD = 1.74$, range = 18 to 26). Just under half of the participants reported that their parents had obtained at least a 4-year degree. Specifically, 48% percent of mothers and 44% of fathers had received a bachelor's degree or higher. With respect to ethnic background, participants identified as White (41%), East Asian (17%), Latina (17%), South Asian (4%), Black (3%), Native American (3%), Middle Eastern (2%), and Other (12%).

Graduate. Women at a northern California university were recruited through emails, course announcements, and flyers. As an incentive, all participants received gift certificates that ranged in value from \$10 to \$20. To be included in the present study, participants needed to be pursuing a doctoral degree in a field related to

science, technology, engineering, or math. The majority of participants (72%) were pursuing a degree in science, followed by technology/computer science (11%), engineering (9%), and math (9%). In total, 102 women participated. Their mean age was 28.36 years ($SD = 5.05$, range = 21 to 52). The majority of participants reported that their parents had obtained at least a 4-year degree. Specifically, 64% percent of mothers and 75% of fathers had received a bachelor's degree or higher. With respect to ethnic background, participants identified as White (72%), East Asian (12%), Latina (6%), Middle Eastern (1%), and Other (10%).

Procedure

Data collection occurred between January and June of 2011 and 2012. The research team that was responsible for data collection included eleven women; one was a graduate student who identified as White, eight were undergraduates who identified as White, and two were undergraduates who identified as biracial. The procedure used for recruiting and data collection differed somewhat depending on whether participants were high school students, undergraduate students, or graduate students. The main difference is that high school students completed a paper-and-pencil version of the survey, whereas undergraduate and graduate students completed an online version of the survey. Additional differences are described below.

High school. Overall, 65% of students who were recruited received parental permission to participate. Approximately one month after the consent forms were sent out, members of the research team returned to each class to collect the completed consent forms and administer the survey. The survey took most students about 40 to

50 minutes to complete, and all participants completed the full survey. Students who did not return their parental consent forms busied themselves with schoolwork for other classes or an alternate assignment provided by the teacher.

Undergraduate and graduate. Undergraduate and graduate students were recruited through a variety of techniques. Specifically, members of the research team made announcements during STEM courses, dropped off flyers in STEM departments, and sent emails to students in STEM fields of study. In addition, several campus organizations that serve STEM undergraduate and graduate students helped to promote the survey. Most participants reported that they heard about the survey through a mailing list or email (29%) or through a professor/advisor (15%). Other participants heard about the survey through a course announcement (10%), a flyer (9%), a friend (6%), or through a combination of recruiting techniques (32%). 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 email were 21% and 35%, respectively.

Undergraduate and graduate students who agreed to participate were provided with a link to an online survey. The first portion of the survey included several screening questions. These questions were used to ensure that participants were, in fact, pursuing STEM degrees and to direct participants to the appropriate survey. (As described below, the surveys had slight wording differences depending on participants' phase of education and their area of study.) After completing the screening questions, participants provided their consent and began the survey. Most

took about 40 to 50 minutes to complete the survey, and all participants completed the full survey.

Measures

Participants completed a survey that included questions about peer group characteristics, experiences with sexism, STEM identification, and the intent to remain in STEM as well as several measures that were not examined in the present study. There were slight wording differences between the surveys used for high school students, undergraduate students, and graduate students. For example, the term “teachers” was used in the survey for high school students, whereas the term “professors” was used in the survey for undergraduates and graduate students. Furthermore, the surveys were tailored to participants’ specific area of study. For example, students in the physical sciences were asked, “In general, how much do you enjoy working on science assignments?,” whereas students in math were asked, “In general, how much do you enjoy working on math assignments?” For the purpose of simplicity, the examples provided throughout the remainder of this section are for undergraduates majoring in a science field.

Each measure is described below. Items were rated on a scale ranging from 1 (*strongly disagree*) to 6 (*strongly agree*) unless otherwise specified. The factor structure and internal reliability of each measure was largely consistent across participants at each of the three phases of education considered in the present study.

Peer climate in STEM. As described below, three affordances of the STEM peer climate were assessed: confidence, motivation, and belongingness. While

completing this portion of the survey, participants were asked to think specifically of their peers in STEM. That is, high school students were asked to respond based on other students in their science or math classes, undergraduates were asked to respond based on the other students in their major, and graduate students were asked to respond based on the other students in their graduate program.

Peer climate items were adapted from a measure that Stake and Mares (2001) administered to students in a science enrichment program and a measure Cameron (2004) developed to assess dimensions of social identity. Participants in the present study were presented with the following prompt: “My experiences and interactions with *other science majors* have...” Following this prompt were three scales that evaluated the influence peers in STEM have on participants’ (1) *motivation* to pursue STEM (“My experiences and interactions with other science majors has had a positive influence on my motivation to achieve in science.”), (2) *confidence* to pursue STEM (“My experiences and interactions with other science majors has made me more confident in my science ability.”), and (3) *belongingness in STEM* (“I have a lot in common with other science majors.”). Exploratory factor analysis indicated that each of the subscales loaded onto separate factors. The internal reliability for *motivation* was acceptable for high school students ($\alpha = .81$), undergraduate students ($\alpha = .89$), and graduate students ($\alpha = .88$). Similarly, the internal reliability for *confidence* was acceptable for high school students ($\alpha = .89$), undergraduate students ($\alpha = .91$), and graduate students ($\alpha = .91$). Finally, the internal reliability for

belongingness was acceptable for high school students ($\alpha = .87$), undergraduate students ($\alpha = .76$), and graduate students ($\alpha = .88$).

STEM identification. The extent to which participants identified with STEM was assessed with a measure that was adapted from Sellers's work on racial identity (e.g., Sellers, Smith, Shelton, Rowley, & Chavons, 1998) and Luhtanen and Crocker's (1992) work on collective self-esteem. This measure was also used by Chemers and colleagues (2011) to examine identity as a scientist in undergraduates and graduate students. Sample items include "Being a scientist is an important part of my self-identity" and "I feel like I belong in the field of science." Exploratory factor analysis indicated that the five *STEM identification* items loaded onto a single factor. The internal reliability for *STEM identification* was acceptable for high school students ($\alpha = .86$), undergraduate students ($\alpha = .82$), and graduate students ($\alpha = .82$).

Intent to remain in STEM. Participants' intent to remain in the STEM pipeline was evaluated with two scales. The first scale was used by Chemers and colleagues (2011) to assess undergraduates' and graduate students' general commitment to a science career (*STEM career commitment*). Sample items include "I will work as hard as necessary to achieve a career in science" and "I feel that I am on a definite career path in science." The second scale, which was developed for the present study, assessed whether participants intend to pursue STEM at a higher phase of education (*next steps commitment*). That is, high school students were asked about their intent to pursue a STEM major in college (e.g., "I plan to major in science in college."), undergraduates were asked about their intent to pursue an advanced degree

in STEM (e.g., “I plan to pursue a master’s or doctoral degree in science.”), and graduate students were asked about their intent to pursue a career in academia (e.g., “I plan to plan to obtain a postdoctoral or tenure-track position in science.”). Factor analysis indicated that that the six *STEM career commitment* items and the three *next steps commitment* items loaded onto two separate factors for the undergraduate and graduate students; for the high school students, however, more support was obtained for a one-factor solution. For the purpose of consistency, *STEM career commitment* and *next steps commitment* were treated as separate constructs for the high school students, and the error terms for these variables were correlated in the path model. (Although caution should be used in correlating error terms, it is sometimes justifiable when two variables tap into the same underlying construct and are similarly worded; these assumptions seem tenable in the present study.) The internal reliability for *STEM career commitment* was acceptable for high school students ($\alpha = .97$), undergraduate students ($\alpha = .92$), and graduate students ($\alpha = .90$). Similarly, the internal reliability for *next steps commitment* was acceptable for high school students ($\alpha = .95$), undergraduate students ($\alpha = .93$), and graduate students ($\alpha = .93$).

Experiences with sexism in STEM. Experiences with sexism in STEM were assessed with items that were adapted from a measure Leaper and Brown (2008) used to examine high school girls’ experiences with academic sexism. Before answering questions about academic sexism, participants were presented with the following prompt:

Gender bias in science occurs when people make *negative comments* about women's science abilities (e.g., "Women are bad at science."). Gender bias in science also occurs when people *treat women unfairly* by encouraging them less than they encourage men. Some people have experienced gender bias in science, but other people have not. We would like to know about *your experiences with gender bias in your science classes or major over the past year*.

Following the prompt were eight examples of academic sexism: (1) intentionally or unintentionally excluded you from a study group because of your gender; (2) made negative comments about women's abilities and science; (3) intentionally or unintentionally excluded you from a discussion about science because of your gender; (4) made you feel like your gender would make it difficult to succeed in science; (5) intentionally or unintentionally ignored your comments or questions during science class because of your gender; (6) made negative comments about your ability to succeed in science because of your gender; (7) made you feel like you had to work harder than male students in order to be taken seriously/respected; (8) expected less of you academically or professionally because of your gender. For each item, participants rated how frequently the following people behaved in that manner: (1) male peers from science classes; (2) female peers from science classes; (3) professors from science classes; and (4) a mentor, advisor, or primary investigator. Participants made frequency ratings on a 4-point scale (1 = *never*, 2 = *once or twice*, 3 = *several times*, 4 = *many times*). However, the distribution of participants' ratings was bimodal

(i.e., many participants experienced no sexism, but there were also many who experienced sexism at least once). For this reason, participants' frequency ratings were converted to a dichotomous scale. Specifically, for each form and source of sexism, participants were divided into two groups according to whether they had or had not experienced it.

Results

Preliminary Analyses

Ethnic composition at each phase of education. Chi-square analyses were used to examine whether the ethnic composition of the sample differed at each phase of education. Results indicated that this was the case. Specifically, Asian American girls were overrepresented in the sample of high school students, Latina women were overrepresented in the sample of college students, and European American women were overrepresented in the sample of graduate students (all $ps < .001$). For this reason, ethnicity is included as a control variable or moderator in all of the forthcoming analyses.

Correlations and mean differences. Tables 1 through 3 present descriptive statistics and correlations among the constructs in the model separately according to participants' phase of education. All correlations across each phase of education were positive, which was the expected directionality. Among girls in high school, the only nonsignificant correlation was between Belongingness and STEM Identification. Among women in college, the only nonsignificant correlation was between Belongingness and STEM Career Commitment. Lastly, among women in graduate

school, Belongingness was not significantly correlated with STEM Identification, STEM Career Commitment, or Next Steps Commitment. Furthermore, Next Steps Commitment was not significantly correlated with any constructs except STEM Career Commitment, although it was marginally correlated with STEM Identification.

A MANOVA was used to test for mean differences in the model's constructs. Specifically, the main effects of ethnicity (Asian American, European American, Latina) and phase of education (high school, college, graduate school) as well as their interaction were examined in a 3 x 3 MANOVA. Results indicated that the main effect for ethnicity and the 2-way interaction between ethnicity and phase of education were nonsignificant ($ps = .382$ and $.530$, respectively). The main effect for phase of education, however, was significant [$F(12, 614) = 2.96, p < .001, \eta^2 = .06$]. Follow-up univariate ANOVAs using Tukey's LSD post-hoc test indicated that this effect was driven by Next Steps Commitment [$F(2, 356) = 31.77, p < .001, \eta^2 = .15$]. Specifically, Next Steps Commitment was higher among girls in high school ($M = 5.07, SD = .78$) than it was among women in college ($M = 4.48, SD = 1.29$) and women in graduate school ($M = 3.81, SD = 1.50$).

Hypotheses 1 and 2: Peer Climate, Identity, and Intent to Remain in STEM

In this set of analyses, I first assessed Hypothesis 1 by testing a mediational model in which affordances from the STEM peer climate (i.e., confidence, motivation, and belongingness) predict participants' identification with STEM, which in turn predict their intent to remain in STEM (see Figure 1). I then assessed

Hypothesis 2a and 2b by examining whether phase of education moderated any of the paths in the model.

Test of the hypothesized model. Path analysis was used to test the mediational model advanced in Hypothesis 1 (see Figure 1). All statistical analyses were performed with EQS 6.1 (Bentler, 2004) using the maximum likelihood estimation method. According to sample size guidelines for path analysis, the ratio of cases to parameters should not be lower than 5:1 (Kline, 2005). The model that was tested in the present study had 12 parameters. Therefore, the case-to-parameter ratio was approximately 11:1 for the high school students, 10:1 for the undergraduates, and 8:1 for the graduate students.

Adequacy of model fit is typically assessed through a chi-square goodness-of-fit test and several additional fit indices (see Hu & Bentler, 1995). The chi-square goodness-of-fit test assesses the difference between the predicted and observed covariance matrices. Therefore, a nonsignificant chi-square is desirable because such a finding implies that the predicted model is not substantially different from the observed model. The comparative fit index (CFI) compares the research model to a null model that does not have any correlations between variables; higher values are better, with values greater than .95 being preferred. The root mean square residual (RMR) and standardized root mean square residuals (SRMR) assess differences between the observed and predicted covariance matrices; lower values are better, with values less than .08 being preferred. Lastly, the root mean square error of

approximation (RMSEA) also assesses the difference between observed and predicted covariance matrices; lower values are better, with values less than .05 being desirable.

The model was specified with an unconstrained multiple-group model, which provided separate path coefficients for participants in high school, college, and graduate school. This was done to ensure that I included all paths that were significant for participants at each phase of education. Analyses revealed that the hypothesized, fully mediated model had mediocre fit, $\chi^2(18, N = 361) = 33.01, p = .02$; CFI = .98, RMR = .08, SRMR = .08, RMSEA = .08 (90% CI: .04, .13).

Examination of the modification indices suggested that a direct path from Belongingness to Next Steps Commitment was missing from the model. Adding this path led to a significant improvement in model fit, $\Delta\chi^2(3, N = 361) = 8.89, p = .031$.

Further examination of the model revealed that the path from Belongingness to STEM Identification was nonsignificant among participants at all three phases of education. This path was therefore dropped from the model, which did not lead to a significant decrement in fit, $\Delta\chi^2(3, N = 361) = .44, ns$. The resulting model had good fit, $\chi^2(18, N = 361) = 24.57, p = .13$; CFI = .99, RMR = .06, SRMR = .06, RMSEA = .06 (90% CI: .00, .10), and was retained as the final model (see Figure 2).

Overall test of phase of education moderation. To test Hypotheses 2a and 2b, which predicted that paths in the model would be moderate by participants' phase of education, I conducted a multiple-group path analysis. This analytic technique tests whether model fit significantly differs from one group to the next by using equality constraints to force parameters to be the same across all groups. The fit of the

constrained model is then compared to the fit of a model in which parameters are allowed to freely vary across all groups. Because the constrained model is nested within the unconstrained model, a chi-square difference test can be used to examine whether the unconstrained model fits significantly better than the constrained model. If it does, there is a significant group difference in model fit (i.e., moderation is occurring).

I began by testing a model in which parameters were forced to be equal for participants in high school, college, and graduate school. A chi-square difference test demonstrated that the unconstrained model fit the data significantly better than the constrained model, $\Delta\chi^2(10, N = 361) = 22.07, p = .015$. Thus, consistent with hypotheses, participant phase of education moderated at least one path in the model (see below for tests of moderation in specific paths).

The path model for girls in high school is depicted in Figure 3. Among these participants, the model accounted for 16% of the variance in STEM Identification, 46% of the variance in STEM Career Commitment, and 31% of the variance in Next Steps Commitment. Consistent with hypotheses, Motivation predicted STEM Identification, which in turn predicted STEM Career Commitment and Next Steps Commitment. A Sobel's test was used to assess the significance of the indirect paths from Motivation to the two Commitment variables via STEM Identification (see MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002). These indirect paths were both significant ($\beta = .19, p = .01$ and $\beta = .15, p = .011$, respectively), which provides support for the hypothesized mediational associations. Inconsistent with hypotheses,

however, Confidence and Belongingness were not significantly associated with STEM Identification; tests of mediation were therefore not conducted with these variables.

The path model for women in college is depicted in Figure 4. Among these participants, the model accounted for 9% of the variance in STEM Identification, 26% of the variance in STEM Career Commitment, and 18% of the variance in Next Steps Commitment. Consistent with hypotheses, Motivation predicted STEM Identification, which in turn predicted STEM Career Commitment and Next Steps Commitment. A Sobel's test was used to assess the significance of the indirect paths from Motivation to the two Commitment variables via STEM Identification. These indirect paths were both significant ($\beta = .13, p = .036$ and $\beta = .10; p = .047$, respectively), which provides support for the hypothesized mediational associations. Inconsistent with hypotheses, however, Confidence and Belongingness were not significantly associated with STEM Identification; tests of mediation were therefore not conducted with these variables.

The path model for women in graduate school is depicted in Figure 5. Among these participants, the model accounted for 15% of the variance in STEM Identification, 50% of the variance in STEM Career Commitment, and 3% of the variance in Next Steps Commitment. Consistent with hypotheses, Confidence predicted STEM Identification, which in turn predicted STEM Career Commitment. A Sobel's test was used to assess the significance of the indirect path from Confidence to STEM Career Commitment via STEM Identification (see MacKinnon

et al., 2002). This indirect path was significant ($\beta = .24, p = .001$), which provides support for the hypothesized mediational association. Inconsistent with hypotheses, however, Motivation and Belongingness were not significantly associated with STEM Identification; tests of mediation were therefore not conducted with these variables.

Differences in specific paths according to phase of education. To identify specific paths in the model that differed for participants in high school, college, and graduate school, equality constraints were imposed on each path one-by-one. Similar to the logic described above, a moderation effect is present if constraining a particular path leads to a significant deterioration in model fit. Analyses indicated that phase of education did not moderate any of the associations between the peer climate affordances and STEM identification; thus, Hypothesis 2a was not supported. However, phase of education did moderate the path from STEM Identification to STEM Career Commitment. Constraining this path for women in college and graduate school led to a significant deterioration in model fit, $\Delta\chi^2(1, N = 361) = 5.74, p = .017$. In partial support of Hypothesis 2b, this path was significantly stronger among women in graduate school ($\beta = .70$) than it was among women in college ($\beta = .51$), but it is important to keep in mind that it was significant for both groups of women.

Participant phase of education also moderated the path from Belongingness to Next Steps Commitment. Constraining this path for women in college and graduate school led to a marginally significant deterioration in model fit, $\Delta\chi^2(1, N = 361) = 3.44, p = .06$. This path was significantly stronger among women in college ($\beta = .16$)

than it was among women in graduate school ($\beta = -.05$). Furthermore, it was significant among women in college, but was nonsignificant among women in graduate school. However, caution should be used in interpreting this finding given that the path from Belongingness to Next Steps Commitment was not hypothesized.

Exploratory analyses examining ethnic differences. Because the ethnic composition of the sample varied across each phase of education (see Method), I conducted exploratory analyses to examine the role participants' ethnic background played in the findings described above. Due to sample size constraints, it was not possible to test for an ethnicity moderation effect in the full path model. Therefore, multiple regression was used to separately test each path in the model for moderation. An examination of the 2-way interactions between ethnicity and the predictors in the model illustrated that most of the paths did not differ according to participant ethnicity. The two ethnic differences that were obtained implied that the model may function better for European American and Asian American participants than for Latina participants. For example, the path from STEM Identification to STEM Career Commitment was significant among Asian American participants ($\beta = .67$) and European American participants ($\beta = .74$), but was nonsignificant among Latina participants ($\beta = .17$). A similar ethnic difference indicated that the path from Motivation to STEM Identification was significant for Asian American ($\beta = .43$) and European American participants ($\beta = .33$), but was nonsignificant among Latina participants ($\beta = -.13$).

Summary: Hypothesis 1 and Hypothesis 2

This set of analyses indicated that, as hypothesized, STEM identification mediated the associations between peer climate affordances and participants' intent to remain in STEM. Specifically, among participants in high school and college, the peer climate affordance of motivation predicted STEM identification, which then predicted general STEM career commitment and commitment to the next educational steps in STEM. Among participants in graduate school, the peer climate affordance of confidence predicted STEM identification, which then predicted general STEM career commitment. The strength of the paths between the affordances and STEM identification did not differ depending on phase of education; hence, Hypothesis 2a was not supported. However, in partial support of Hypothesis 2b, the path from STEM identification to STEM Career Commitment was significantly stronger for women in graduate school than for women in college. Finally, exploratory analyses demonstrated that several of the paths in the model were nonsignificant among Latina participants, which suggests that the model may not be especially effective in predicting these girls' and women's intent to remain in STEM.

Hypotheses 3 and 4: Peer Support and Sexism

In this set of analyses, I tested Hypothesis 3 by examining whether participants reported experiencing greater levels of sexism as their phase of education increased. I then tested Hypothesis 4 by examining whether peer support buffers, or moderates, the effect that experiencing sexism has on girls' and women's intent to remain in STEM. Findings for both hypotheses are presented in the two sections that follow.

Rates of sexism. Chi-square analyses were used to test Hypothesis 3, which predicted that experiences with sexism would become more frequent with increasing education. That is, I anticipated that graduate students would experience the most sexism, followed college students, and then high school students. Table 4 lists the eight forms and four sources of sexism that participants rated; the percentage of participants who reported experiencing each is broken down according to whether participants were in high school, college, or graduate school. Contrary to hypotheses, analyses indicated that women in college reported experiencing more sexism than their counterparts in high school and graduate school. Specifically, women in college reported experiencing significantly more sexism than other participants across five of the eight forms of bias that were rated. With respect to the sources of sexism, results showed that male peers were an especially common source of sexism, particularly for girls and women in high school and college. Also, analyses demonstrated that women in college and graduate school were significantly more likely than girls in high school to experience sexism from a teacher or a professor. Finally, I collapsed across all forms and sources of sexism to examine whether participants in high school, college, and graduate school differed in the overall amount of sexism they reported experiencing. Analyses indicated that this was not the case: overall, 55% of girls in high school, 64% of women in college, and 60% of women in graduate school reported experiencing at least one instance of sexism over the past year [$\chi^2(2, N = 361) = 2.21, ns$].

Follow-up analyses demonstrated that the findings described in this section generally did not differ according to participants' ethnic background. That being said, a few significant differences were obtained. At the high school level, European American girls were more likely than other girls to report that others had (a) made them feel like their gender would make it difficult for them to succeed in science [$\chi^2(2, N = 134) = 9.09, p < .001$] and (b) ignored their comments or questions within a science context [$\chi^2(2, N = 134) = 8.16, p = .017$]. These girls were also more likely than other participants to report experiencing bias from female peers in STEM [$\chi^2(2, N = 134) = 8.39, p = .015$].

Buffering effect of peer support. Multiple regression was used to test Hypothesis 4, which predicted that experiences with sexism would moderate the association between peer support and participants' intent to remain in STEM. Specifically, I anticipated that the association between peer support and the intent to remain in STEM would be stronger for participants who had experienced sexism than for participants who had not. Two regression models were estimated: the first included participants' STEM career commitment as the outcome variable, whereas the second included participants' next steps commitment as the outcome variable. The hypothesized moderation effect was nonsignificant in the first of these models; hence, the remainder of this section focuses on the findings for the model that examined participants' next steps commitment.

The regression model included participants' age and ethnic background as control variables. Age was treated as a continuous variable, whereas ethnic

background was dummy coded to account for the effect of identifying as Asian American, European American, or Latina. Additional predictors included participants' experiences with sexism, which was treated as a dichotomous variable (see Method section), as well as a composite variable that assessed the overall amount of support that participants received from their peers in STEM. Lastly, an interaction term was created to assess the hypothesized 2-way interaction between peer support and experiences with sexism. (The 3-way interaction between peer support, experiences with sexism, and phase of education was also tested, but it was nonsignificant and is not further discussed.) All continuous variables were centered to reduce the likelihood of multicollinearity and to facilitate interpretation (Aiken & West, 1991). Regression diagnostics indicated that multicollinearity was not a problem in these analyses.

Analyses demonstrated that the regression model accounted for 17% of the variance in participants' next steps commitment. As detailed in Table 5, being younger was associated with greater commitment as was identifying as Asian American or Latina. More pertinent to Hypothesis 4, however, was the significant 2-way interaction between peer support and experiences with sexism. To probe the interaction, I tested the regression model separately among participants who had and had not experienced sexism. As hypothesized, peer support significantly predicted girls' and women's next steps commitment only among participants who had experienced sexism ($\beta = .17, t = 4.16, p < .001$). This indicates that among participants who experienced sexism, greater peer support was associated with greater

next steps commitment. In contrast, peer support was not associated with next steps commitment among participants who had not experienced sexism.

Summary: Hypothesis 3 and Hypothesis 4

This set of analyses demonstrated that over half of the participants at each phase of education experienced sexism at least once over the course of the past year. In partial support of Hypothesis 3, women in college generally reported experiencing more sexism than did their counterparts in high school and graduate school. Moreover, consistent with Hypothesis 4, peer support was significantly associated with commitment to the next steps in STEM among women who had experienced sexism. Finally, exploratory analyses indicated that the general pattern of results did not substantially differ across ethnic groups. However, several findings did suggest that among high school students, European American girls may be especially likely to report experiencing sexism.

Discussion

Throughout the past decade, policymakers, educators, and researchers have emphasized the importance of promoting greater diversity in STEM fields. To this end, the present study sought to shed light on connections between peer influences and girls' and women's pursuit of STEM careers. Given that girls and women become more poorly represented in STEM with increased progress through the educational pipeline, I also examined whether peer effects differ depending on phase of education. Below, I describe findings from the present study that highlight the role peers play in girls' and women's identification with STEM and, by extension, their intent to remain in STEM. I then discuss findings that pertain to girls' and women's experiences with sexism in STEM. Lastly, I highlight limitations and corresponding directions for future research.

Peer Climate, Identity, and Intent to Remain in STEM

Test of the mediational model. Prior research shows that peers can influence students' interest and retention in STEM (Crosnoe et al., 2008; Stake & Nickens, 2005). However, less is known about *why* peers are influential. Put differently, mediators of peer effects have received relatively little attention (see Brechwald & Prinstein, 2011). Drawing from research on social identity and peer connectedness (e.g., Cohen & Garcia, 2008), I anticipated that STEM identification may serve this mediational function. Hence, my first hypothesis was that the peer climate affordances of confidence, motivation, and belongingness would predict girls' and

women's STEM identification, which would in turn predict their intent to remain in STEM.

Analyses carried out with path analysis generally supported the hypothesized mediational model. The main deviation from hypotheses involved the predicted path from belongingness to STEM identification, which was nonsignificant among girls and women at all three phases of education. Notably, the bivariate correlation between these variables was significant or marginally significant at each phase of education. This finding implies that confidence and motivation statistically trump belongingness when all three are simultaneously tested as predictors of STEM identification. That is, when motivation and confidence are entered into the model, there is not enough leftover variance in STEM identification for belongingness to function as a significant predictor. Belongingness did, however, predict undergraduates' intent to pursue an advanced degree in STEM, which indicates that it is still an important peer climate affordance.

Consistent with expectations, STEM identification mediated several of the associations between peer climate affordances and the intent to remain in STEM. For participants in high school and college, the extent to which the peer climate promoted motivation predicted STEM identification; in turn, STEM identification predicted both general STEM career commitment and commitment to taking the next educational steps in STEM. Similarly, for participants in graduate school, the extent to which the peer climate promoted confidence predicted STEM identification; in turn, STEM identification predicted general STEM career commitment.

Collectively, the findings pertaining to the mediational model align with theory and research indicating that social relationships play an important role in shaping identity (e.g., Harris, 1995; Tajfel & Turner, 1986). In addition, the present study builds on prior research that has linked peers to students' academic trajectories (Kessels, 2005; Stake, 2003). Namely, the results imply that peers are influential because they can enhance the likelihood that a particular academic domain is incorporated into one's sense of self. This possibility is intriguing given that girls and women appear to face more barriers in coming to identify with STEM than do boys and men (London et al., 2011; Settles et al., 2009). Therefore, from an applied standpoint, these findings suggest that outreach programs aimed at increasing gender parity in STEM would benefit from an explicit emphasis on fostering social ties among the girls and women they serve.

Test of model differences as a function of phase of education. The present study also examined whether the mediational model differed for participants in high school, college, and graduate school. Although there was an overall moderation effect for phase of education, follow-up analyses testing for moderation effects in individual paths provided only limited support for predictions. First, due to the unique contextual features of STEM graduate programs (e.g., Fox, 2000), Hypothesis 2a predicted that the paths from the peer affordances to STEM identification would be stronger for women in graduate school than for other participants. This hypothesis was not supported: phase of education did not moderate any of the paths between affordances and STEM identification. However, as described later, there is some

evidence that different peer climate affordances were important at different phases of education.

Hypothesis 2b predicted that STEM identification and the intent to remain in STEM would become more closely related as education increased. This prediction was grounded in research suggesting that identity and career goals become more closely fused over time (Estrada et al., 2010). Phase of education did not moderate the path from STEM identification to participants' commitment to the next steps in STEM. However, in partial support of hypotheses, the path from STEM identification to participants' general STEM career commitment was significantly stronger for women in graduate school than for women in college.

In addition to the formal tests of moderation described above, two phase of education differences in the models merit further discussion. First, for participants in high school and college, motivation was the only peer climate affordance that predicted STEM identification. In contrast, among women in graduate school, confidence was the only peer climate affordance that predicted STEM identification. These findings suggest that peer influences on motivation are most relevant for high school and college students, whereas peer influences on confidence are most relevant for graduate students. Research examining the experiences of women in STEM graduate programs sheds light on this pattern. Specifically, many women in STEM graduate programs are already highly motivated, but they face challenges such as social isolation that could undermine their confidence (e.g., Herzig, 2002). Thus,

these women may be especially likely to benefit from a STEM peer climate that makes them feel more confident in their STEM abilities.

A second phase of education difference pertains to girls' and women's commitment to pursuing the next educational steps in STEM. For girls in high school, the next step was obtaining an undergraduate degree in STEM; for women in college, the next step was obtaining a graduate degree in STEM; and for women in graduate school, the next step was obtaining a postdoctoral or tenure-track position in STEM. Tests of mean-level differences in next steps commitment mirrored the leaky pipeline phenomenon: Girls in high school were more committed to the next educational steps than were women in college, and women in college were more committed than were women in graduate school. Moreover, the model accounted for very little variance in graduate students' next steps commitment (3%), especially in comparison to the variance accounted for among high school and college students (31% and 18%, respectively). Thus, the constructs examined in the present study may not be ideal predictors of women's retention in the STEM pipeline at the graduate level. Consistent with this point, several researchers have argued that perceptions of work-family conflict outweigh all other factors in determining whether or not women in STEM graduate programs pursue careers in academia (see Ceci, Williams, & Barnett, 2011).

Experiences with Sexism

A second set of analyses assessed participants' experiences with sexism in STEM. The first goal was to examine the prevalence rates of sexism at each phase of

education. The second goal was to examine whether having a supportive STEM peer climate is especially important for girls and women who have experienced sexism. Findings pertaining to each goal are described below.

Sexism prevalence rates. Overall, 54% of girls in high school, 64% of women in college, and 60% of women in graduate school reported experiencing at least one instance of sexism over the past year, and male peers from STEM were the most common source of sexism across all three phases of education. Notably, these results align with findings obtained in Leaper and Brown's (2008) study of adolescent girls' experiences with sexism. Specifically, 52% of the girls in their sample reported experiencing academic sexism, and male peers and friends were a frequently cited source.

Beyond assessing the overall prevalence of sexism, an important aim of the present study was to establish whether sexism becomes more common with increased progress through the educational pipeline (see Etzkowitz et al., 2000; Herzig, 2002). Specifically, Hypothesis 3 predicted that women in graduate school would report experiencing more sexism than women in college, who would in turn report experiencing more sexism than girls in high school. This hypothesis received partial support: Across five of the eight forms of sexism that participants rated, the prevalence rates were higher for women in college than they were for girls in high school *and* women in graduate school.

In some respects, it is unsurprising that women in college reported experiencing more sexism than did other participants. The transition to college tends

to be challenging, and mounting evidence suggests that these challenges are magnified for students who are underrepresented at their institution and/or within their major (e.g., London et al., 2011; Rosenthal et al., 2011; Syed et al., 2011). Indeed, London and colleagues noted that “women in nontraditional fields such as STEM face all of the typical stress of the transition to college plus gender bias and stereotype threat” (p. 307). Therefore, the results of the present study join a growing body of research indicating that undergraduate education may be a worthwhile target for interventions and outreach.

Peer support and experiences with sexism. The final goal of the present study was to examine whether having a supportive network of peers in STEM might be especially important for girls and women who have experienced sexism. Specifically, Hypothesis 4 predicted that the association between peer support and the intent to remain in STEM would be stronger for participants who have experienced sexism than for participants who have not. This hypothesis was not supported when the outcome variable was participants’ general STEM career commitment, but it was supported when the outcome variable was participants’ commitment to the next educational steps in STEM. In other words, the association between peer support and next steps commitment was significantly stronger for girls and women who have experienced sexism than it was for other participants. Also, as anticipated, phase of education did not function as a moderator in these analyses, which implies that peer support is beneficial to girls and women who experience sexism regardless of their phase of education.

These findings are consistent with research indicating that social support can be helpful to girls and women who experience sexism (Lazarus & Folkman, 1984; Leaper & Robnett, 2011; London et al., 2011). Moreover, by focusing on support from peers in STEM, the present study builds on past work that has established a link between women's retention in STEM and the supportiveness of their friends and family outside of STEM (London et al., 2011). An important caveat is that I did not directly examine participants' use of social support as a coping response. Instead, I inferred that participants with a supportive STEM peer network would have access to social support if needed. Future research should directly examine the extent to which girls and women utilize their peers in STEM to cope with sexism and other challenges.

Limitations and Future Directions

The present study has several limitations, which I now highlight along with corresponding directions for future research. First, the present study does not provide definitive information about the directionality of the associations between peer climate affordances, STEM identification, and the intent to remain in STEM. Notably, there is strong precedent for a causal flow that runs from STEM identification to the intent to remain in STEM (Chemers et al., 2011; Estrada et al., 2010; Lent & Brown, 2006). Less clear, however, is the directionality of the association between the peer climate affordances and STEM identification. For example, it could be the case that girls and women who are high in STEM identification elicit support from their peers in STEM, which is the reverse of what

was proposed in the present study. Longitudinal research would shed more light on the association between these constructs. Indeed, Maxwell and Cole (2007) note that longitudinal data provides a stronger test of directionality within mediational models than does cross-sectional data.

Another methodological limitation of the present study is its reliance on self-report measures. This weakness may be especially relevant for the analyses assessing the prevalence of sexism in STEM. Prior research indicates that people are often unable or unwilling to attribute negative experiences to discrimination (Crosby, 1984; Kaiser & Miller, 2001). Thus, it may be that the prevalence of sexism in STEM was underreported in the present study. Collecting information about peers' and mentors' endorsement of sexist ideologies would provide further insight into the commonality of sexism in STEM (see Moss-Racusin et al., 2012).

The conclusions drawn from the present study would be further enhanced through the use of behavioral outcome measures. Ideally, students' intent to remain in STEM is predictive of their retention in the STEM pipeline, but my findings do not directly speak to this possibility. However, there is some evidence that behavioral intentions are effective predictors of actual behavior within an academic context (e.g., Estrada et al., 2010). Therefore, examining outcomes such as grades, applications to graduate school, and matriculation to the next phase of education could be a fruitful direction for future research.

A final limitation of the present study pertains to participants' ethnic background at each phase of education. Specifically, Asian American girls were

overrepresented in the sample of high school students, Latina women were overrepresented in the sample of college students, and European American women were overrepresented in the sample of graduate students. For this reason, tests of ethnic differences were included in each set of analyses. Although phase of education often moderated the findings, ethnicity rarely did. Thus, most of the findings obtained in the present study appear to be consistent across ethnic groups. There was, however, some evidence that paths in the mediational model were weaker for Latina participants than for other participants, which is consistent with research that has tested similar models in undergraduate and graduate samples (e.g., Syed et al., 2013). Future research using large, ethnically diverse samples should seek to determine why this is the case.

A related direction for future research pertains to intersectionality (see Hill Collins, 1986). To elaborate, it seems plausible that intersecting identities contour students' experiences in STEM fields. For example, a man who is African American likely faces different challenges in his pursuit of a STEM degree than does a woman who is European American. Although several qualitative studies have provided rich insight into the experiences that people of color have in STEM fields (e.g., Johnson, 2007), this work would be bolstered by large-scale quantitative and mixed-methods studies that make targeted comparisons between participants who differ on the basis of crosscutting social identities (see Wood, Kurtz-Costes, & Copping, 2011).

Lastly, the present study has implications for outreach programs aimed at improving educational equity in STEM. These programs are becoming increasingly common, but many are not guided by theory or past research (see Chemers et al., 2011). Thus, several findings from the present study that can be directly applied to outreach programs are listed as follows. First, the present study suggests that strong ties to peers in STEM are important; they can shape the extent to which students identify with STEM and can potentially buffer the negative effects of experiencing sexism. Thus, an explicit emphasis on fostering ties among the students who participate in outreach programs could enhance program effectiveness. Work from the social psychology literature (e.g., Cohen & Garcia, 2008) provides a starting point for understanding how to create these ties. In addition, the results of the present study indicate that women in college experience more sexism than do girls and women in other phases of education. Moreover, the most common source of sexism was men who were also in the STEM pipeline. For this reason, it would be beneficial to implement outreach programs that teach women *and* men in STEM majors how to recognize and combat sexism. In particular, it may be important to provide information about subtle forms of bias such as modern and benevolent sexism (e.g., Moss-Racusin et al., 2012).

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Table 1
Descriptive Statistics and Correlation Matrix for Girls in High School

Variable	1	2	3	4	5	6
1. Confidence	--					
2. Motivation	.63	--				
3. Belongingness	.34	.42	--			
4. STEM Identification	.33	.38	.16	--		
5. STEM Career Commitment	.31	.35	.27	.68	--	
6. Next Steps Commitment	.25	.33	.31	.54	.90	--
Mean	3.91	4.30	4.36	3.65	4.74	5.07
Standard Deviation	.96	.89	.92	.97	.86	.78

Note. $N = 134$. All variables were rated on a scale ranging from 1 (*strongly disagree*) to 6 (*strongly agree*). Values in bold represent correlations that are significant at the .05 level or higher.

Table 2
Descriptive Statistics and Correlation Matrix for Women in College

Variable	1	2	3	4	5	6
1. Confidence	--					
2. Motivation	.70	--				
3. Belongingness	.36	.53	--			
4. STEM Identification	.23	.29	.20	--		
5. STEM Career Commitment	.25	.31	.15	.51	--	
6. Next Steps Commitment	.28	.36	.26	.40	.64	--
Mean	4.35	4.61	3.92	4.26	4.88	4.48
Standard Deviation	1.01	.96	1.03	.89	.85	1.29

Note. $N = 125$. All variables were rated on a scale ranging from 1 (*strongly disagree*) to 6 (*strongly agree*). Values in bold represent correlations that are significant at the .05 level or higher.

Table 3
Descriptive Statistics and Correlation Matrix for Women in Graduate School

Variable	1	2	3	4	5	6
1. Confidence	--					
2. Motivation	.44	--				
3. Belongingness	.40	.61	--			
4. STEM Identification	.38	.23	.18	--		
5. STEM Career Commitment	.41	.27	.17	.71	--	
6. Next Steps Commitment	.08	.16	.01	.17	.38	--
Mean	4.34	4.90	4.21	4.67	4.75	3.81
Standard Deviation	1.10	.81	1.22	.79	.85	1.50

Note. $N = 102$. All variables were rated on a scale ranging from 1 (*strongly disagree*) to 6 (*strongly agree*). Values in bold represent correlations that are significant at the .05 level or higher.

Table 4

Percentage of Participants in High School, College, and Graduate School Who Reported Experiencing Sexism Over the Past Year

	% Who Experienced at Least Once Over the Past Year				
	High School	College	Graduate	Overall	χ^2
Forms of Sexism					
Made you feel like you had to work harder than male students to be taken seriously or respected.	37.3	42.5	34.7	38.4	1.49
Made negative comments about girls and women's abilities in STEM.	33.6	48.5 ^a	27.8	36.7	9.75 ^{**}
Made you feel like your gender will make it difficult for you to succeed in STEM.	26.9 ^b	40.8	40.4	35.3	6.86 [*]
Expected less of you academically or professionally because of your gender.	23.1	32.5 ^a	17.9	24.9	6.42 [*]
Excluded from science study group because of your gender.	19.4	29.2 ^a	13.7	21.2	8.03 [*]
Excluded you from a discussion about STEM because of your gender.	10.4	26.9 ^a	18.9	18.4	11.38 ^{**}
Made negative comments about your ability in STEM because of your gender.	13.7	23.3	14.7	17.3	4.64
Ignored your comments or questions in STEM classes because of your gender.	9.7	22.7 ^a	9.6	14.1	10.96 ^{**}
Sources of Sexism					
Male peers in STEM.	50.0	59.2	35.8 ^b	49.3	11.64 ^{**}
Female peers in STEM.	23.9	37.5	32.6	30.9	5.67
A STEM teacher or professor.	17.2 ^b	35.8	35.8	28.7	14.05 ^{**}
A mentor or advisor in STEM.	22.4	27.7	32.2	24.4	1.09
Overall (collapsing across all forms/sources)	54.5	63.5	59.8	59.1	2.21

Note. $N = 361$. Forms and sources of sexism are sorted in ascending order according to their overall prevalence in the sample. ^a Cell frequency is higher than would be expected by chance. ^b Cell frequency is lower than would be expected by chance.

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

Table 5

Regression Model Testing the 2-Way Interaction between Peer Support and Sexism

	<i>B</i>	<i>SE</i>	β
Age	-.07	.01	-.31***
Ethnicity: Asian/Pacific Islander	.48	.23	.18*
Ethnicity: European American	.23	.22	.09
Ethnicity: Latina	.74	.28	.16**
Peer Support	.06	.13	.04
Sexism	.21	.13	.08
Peer Support x Sexism Interaction	.34	.16	.17*

Note. $N = 361$. The overall model was significant, $F(7, 354) = 11.70, p < .001, R^2 = .17$. All continuous predictor variables were centered.

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

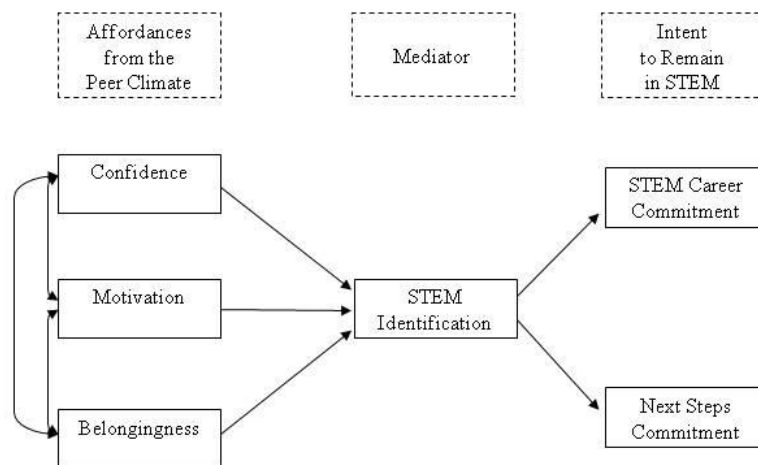


Figure 1. Conceptual model depicting the hypothesized mediational association between affordances from the peer climate, STEM identification, and intent to remain in STEM.

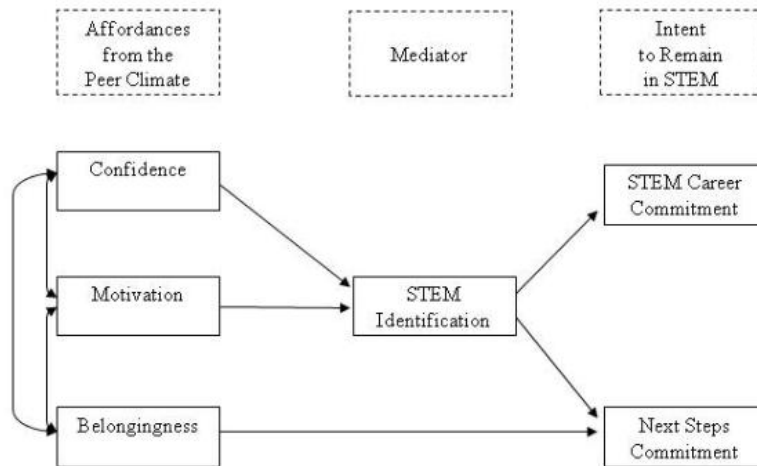


Figure 2. Final model assessed in multiple-group analyses. $\chi^2(21, N = 361) = 33.46, p = .04$; CFI = .98, RMR = .05, SRMR = .08, RMSEA = .06 (90% CI: .01, .09). Correlated error terms between the commitment variables are not depicted.

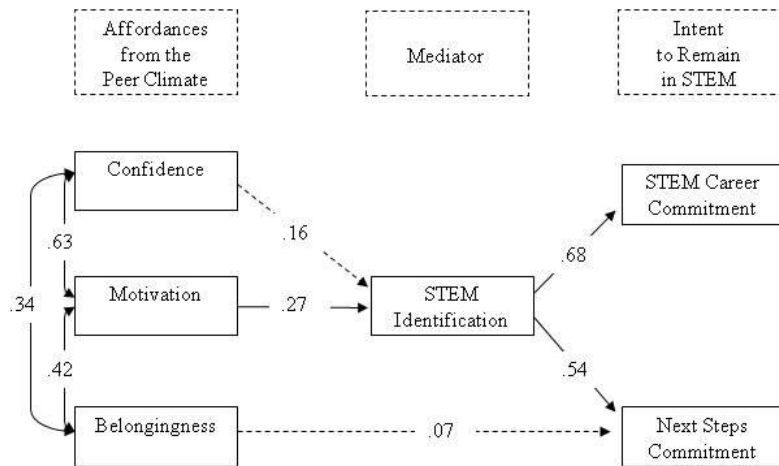


Figure 3. Standardized path coefficients for girls in high school ($N = 134$). The correlated error term between the commitment variables is not depicted. Paths are significant at the .05 level unless dashed.

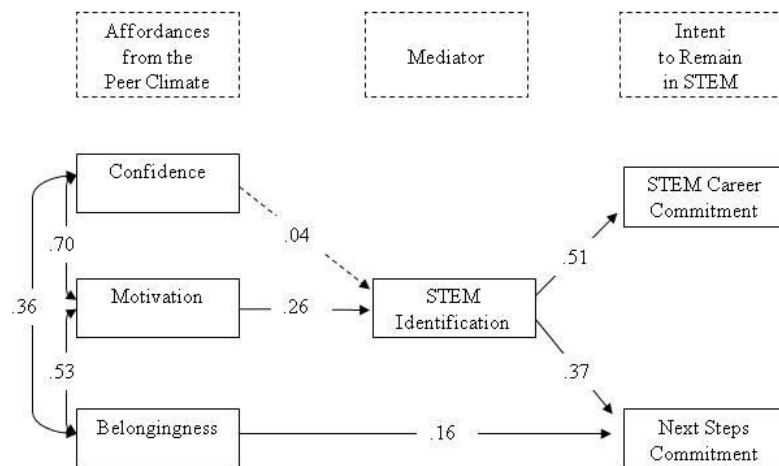


Figure 4. Standardized path coefficients for women in college ($N = 125$). The correlated error term between the commitment variables is not depicted. Paths are significant at the .05 level unless dashed.

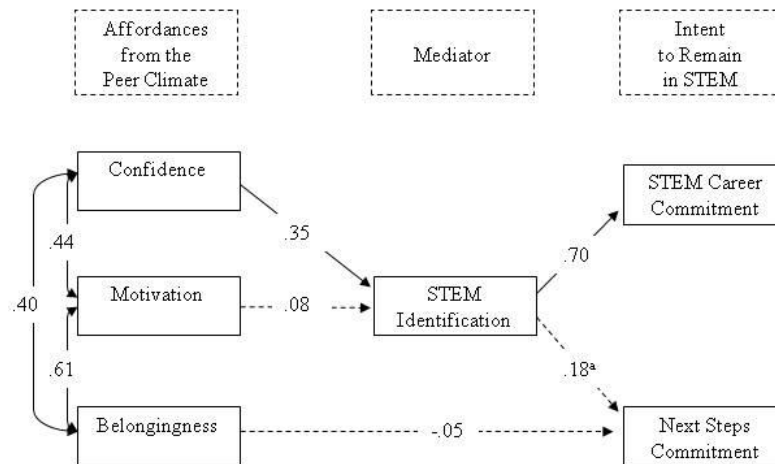


Figure 5. Standardized path coefficients for women in graduate school ($N = 102$). The correlated error term between the commitment variables is not depicted. Paths are significant at the .05 level unless dashed. *Path is marginally significant ($p = .078$).