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The Role of Peer Support for Girls and Women in the STEM Pipeline: Implications for Identity and Anticipated Retention

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ABSTRACT

The present study examined the role peers play in girls' and women's intent to pursue careers in science, technology, engineering, and math (STEM). The primary goal was to test a mediational model in which three affordances from the STEM peer climate (motivation, confidence, and belongingness) predicted girls' and women's identification with STEM, which in turn predicted their intent to remain in STEM. In testing the model, particular attention was paid to differences that were driven by participants' phase of education. The sample included STEM-oriented girls and women who attended high school, college, or graduate school in the United States. Analyses carried out with path analysis supported the hypothesized mediational model. Among high school and college students, STEM peers' influence on motivation predicted participants' STEM identification, which in turn predicted their intent to pursue a STEM career. Similarly, among graduate students, STEM peers' influence on confidence predicted participants' STEM identification, which in turn predicted their intent to pursue a STEM career. As anticipated, participants' phase of education moderated several of the paths in the model. Discussion highlights both theoretical and applied implications.

KEYWORDS

Gender; STEM; occupational aspirations; social identity; peer relationships; adolescence; emerging adulthood

The Role of Peer Support for Girls and Women in the STEM Pipeline: Implications for Identity and Anticipated Retention

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, 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., 2005; 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.

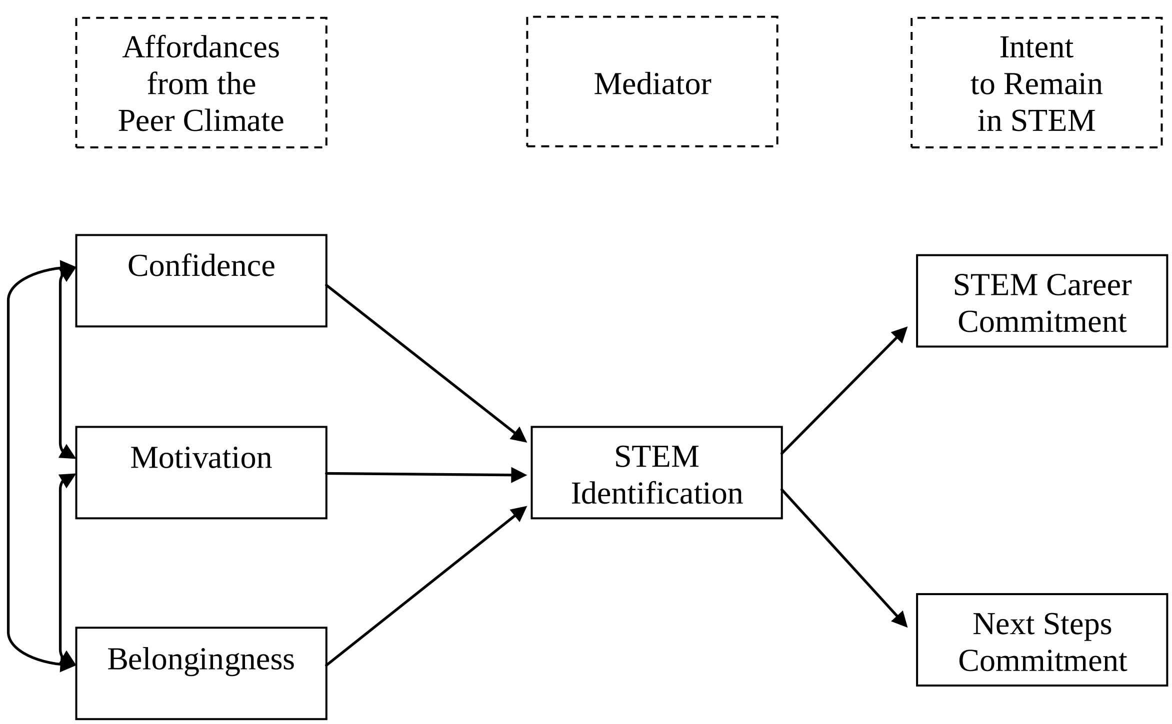

Figure 1. Conceptual model depicting the hypothesized mediational associations between affordances from the peer climate, STEM identification, and intent to remain in STEM.

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, & Muller, 2006; Stake & Nickens, 2005), less is known about constructs that underlie peer influences (e.g., Brechwald & Prinstein, 2011). Thus, the primary 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). In addition, 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 (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.

BACKGROUND

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). For example, having close friends who are high-achieving is associated with a greater likelihood of enrolling in advanced courses during high school (Crosnoe, Riegle-Crumb, Field, Frank, & Muller, 2008). Notably, this association appears to be especially strong for girls' advanced course taking in math and science (Riegle-Crumb et al., 2006). It is therefore troubling that relative to adolescent boys, adolescent girls tend to report that their peers are not as supportive of their pursuit of STEM careers (Kessels, 2005; Robnett & Leaper, 2013; Stake & Nickens, 2005).

Peers also play an important role for women who are pursuing STEM degrees during college and graduate school. Specifically, several studies suggest that some women in STEM majors and STEM graduate programs struggle with feelings of social isolation (Herzig, 2002; Margolis, Fisher, & Miller, 2000; Zeldin & Pajares, 2000). For example, Margolis and colleagues (2000) found that a subset of women in their sample quickly lost interest in computer science because they felt like they were the only ones struggling with their coursework. This led the authors to argue that forming close, supportive bonds with other computer science students may be vital for women's retention in the field. The benefits of peer support were also highlighted in the 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 summary, 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; Riegle-Crumb et al., 2006; Robnett & Leaper, 2013; 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 predicts their intent to remain in STEM.

STEM Identification and Gender-Related Barriers

Theorists have long noted that forging an occupational identity is an important developmental milestone during adolescence and emerging adulthood (Arnett, 2004; Erikson, 1968). In its most basic form, occupational identity can be conceptualized as identification with a specific career or academic domain. 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.

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). Specifically, some girls and women in STEM perceive an incompatibility between their gender identity and their academic identity (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 lower performance in STEM classes and lower general wellbeing (see also London et al., 2011).

Peer Climate Affordances as a Means of Promoting STEM Identification

It should be evident 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; Tajfel & Turner, 1986). Accordingly, having a supportive STEM 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 linked social connections to 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, Rattan, & Dweck, 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).

As a whole, this body of research suggests that the STEM peer climate is linked to 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.

Phase of education as a moderator

The hypothesized mediational associations were expected to emerge among girls and women at all three phases of education. However, it was also expected that several associations would differ in strength depending on whether participants were in high school, college, or graduate school. To elaborate, graduate departments are microcosms with their own norms, expectations, and idiosyncrasies, which is less likely to be the case in most STEM majors and STEM high school classes (Fox, 2000). Thus, it was predicted that the link between features of the STEM peer climate and STEM identification would be strongest among women in STEM graduate programs. In addition, the link between STEM identification and the intent to remain in STEM was expected to become increasingly strong with increased progress through the educational pipeline. This is because there is evidence that academic identity and career plans become more closely fused as education progresses (Estrada et al., 2010).

The Present Study

The primary goal of the present study was to examine the associations between the STEM peer climate, STEM identification, and the intent to remain in STEM. Specifically, Hypothesis 1 was that affordances from the STEM peer climate (i.e., belongingness, motivation, and confidence) would predict participants' STEM identification, which would in turn predict participants' intent to remain in STEM (see Figure 1). 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. Thus, 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.

METHOD

Participants

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. In total, 400 girls participated. However, analyses for the present study focused on a subset of girls who were at least moderately interested in pursuing a STEM career. Thus, the final sample included 134 girls whose mean age was 16.52 years (*SD* = .96, range = 14 to 18). With respect to ethnic background, participants identified as East Asian (53%), South Asian (29%), White (18%), Latina (2%), Middle Eastern (2%), and Other (2%). Although a direct measure of socioeconomic background was not obtained, the majority of participants reported that their parents had obtained at least a 4-year degree. Specifically, 75% percent of participants' mothers and 84% of participants' fathers had received a bachelor's or graduate degree.

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. In total, 125 women participated. Their mean age was 20.28 years (*SD* = 1.74, range = 18 to 26). The majority of participants (66%) were pursuing a degree in science, followed by technology/computer science (16%), engineering (12%), and math (6%). 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%). Just under half of the participants reported that their parents had obtained at least a 4-year degree. Specifically, 48% percent of participants' mothers and 44% of participants' fathers had received a bachelor's degree or higher.

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

Procedure
Data collection occurred during the spring 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. As described below, the procedure used for recruiting and data collection differed somewhat depending on whether participants were high school students, undergraduate students, or graduate students.

High school
Math and science teachers at each participating school were provided with information about the study and the logistics of data collection. Teachers who agreed to let data collection occur in their classes received parental consent forms to send home with their students. Overall, 65% of students 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.

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. 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 survey took most students about 40 to 50 minutes to complete.

Measures
Participants completed a survey that included questions about their peers in STEM, STEM identification, intent to remain in STEM, and 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 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*).

Peer climate in STEM

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 responded based on other students in their science or math classes, undergraduates responded based on the other students in their major, and graduate students responded based on the other students in their graduate program.

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 (4 items; e.g., "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 (4 items; e.g., "My experiences and interactions with other science majors has made me more confident in my science ability."); and (3) *belongingness in STEM* (3 items; e.g., "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 (α = .81), undergraduate students (α = .89), and graduate students (α = .88). Similarly, the internal reliability for *confidence* was acceptable for high school students (α = .89), undergraduate students (α = .91), and graduate students (α = .91). Finally, the internal reliability for *belongingness* was acceptable for high school students (α = .87), undergraduate students (α = .76), and graduate students (α = .88).

STEM identification

The extent to which participants identified with STEM was assessed with five items that were 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 am a scientist." Exploratory factor analysis indicated that that the *STEM identification* items loaded onto a single factor. The internal reliability for *STEM identification* was acceptable for high school students (α = .86), undergraduate students (α = .82), and graduate students (α = .82).

Intent to remain in STEM
Participants' intent to remain in the STEM pipeline was evaluated with two scales. The first scale, which included six items, 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 included three items, was developed for the present study and assessed participants' intent 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, undergraduates were asked about their intent to pursue an advanced degree in STEM, and graduate students were asked about their intent to pursue a career in academia. Factor analysis indicated that the *STEM career commitment* items and the *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 were tenable in the present study.) The internal reliability for *STEM career commitment* was acceptable for high school students (α = .97), undergraduate students (α = .92), and graduate students (α = .90). Similarly, the internal reliability for *next steps commitment* was acceptable for high school students (α = .95), undergraduate students (α = .93), and graduate students (α = .93).

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 this 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 *p*s < .001). The implications of these ethnic differences are discussed more fully below.

Correlations and mean differences
Tables 1 to 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. A multivariate analysis of variance (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 (*p*s = .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, girls in high school ($M = 5.07$, $SD = .78$) were higher in Next Steps Commitment than were women in college ($M = 4.48$, $SD = 1.29$), who were in turn higher than women in graduate school ($M = 3.81$, $SD = 1.50$).

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.

Testing the Mediational 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. Adequacy of model fit was assessed through a chi-square goodness-of-fit test and several additional fit indices (see Hu & Bentler, 1995). The model was specified with an unconstrained multiple-group model, which provided separate path coefficients for participants in high school, college, and graduate school.

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).

To test Hypotheses 2a and 2b, which predicted that paths in the model would be moderated by participants' phase of education, a multiple-group path analysis was carried out. 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.

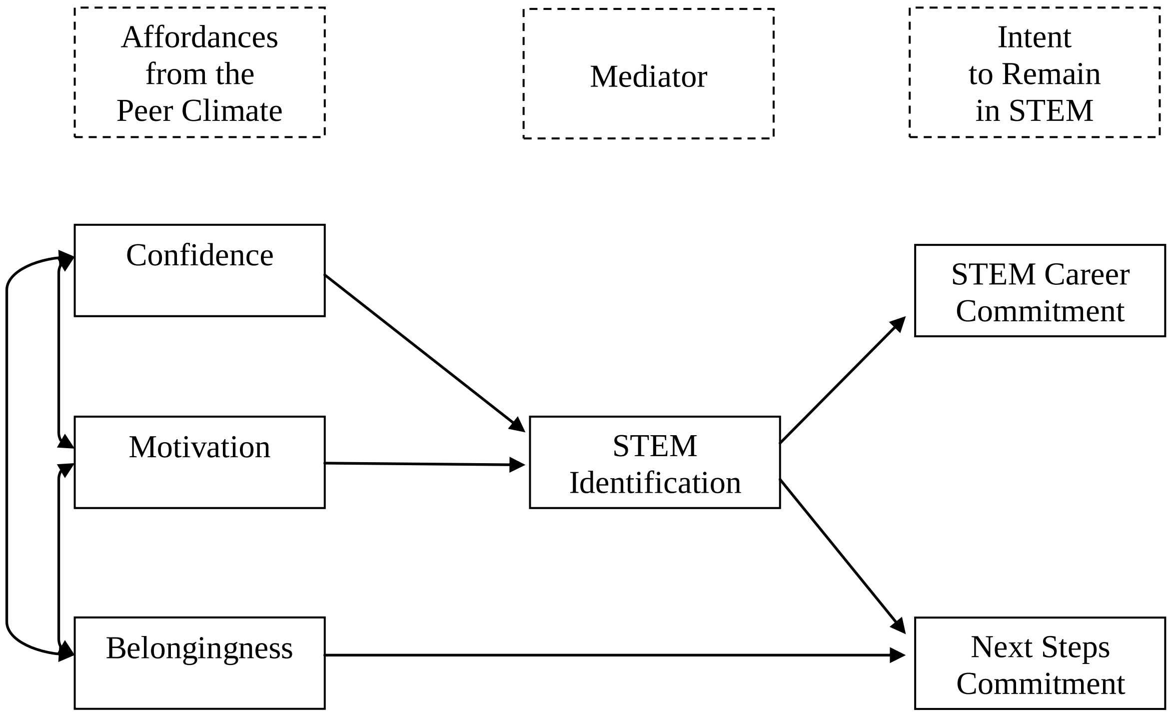

Figure 2. Final model assessed in multiple-group analyses. X^2(21, N = 361) = 33.46, p = .04; CFI = .98, RMR = .05, SRMR = .08, RMSEA = .06 (90% CI: .01, .09). Correlated error terms between the commitment variables are not depicted.

Overall test of phase of education moderation

The first model that was tested was one 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 expectations, 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 (β = .19, $p = .010$ and β =.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.

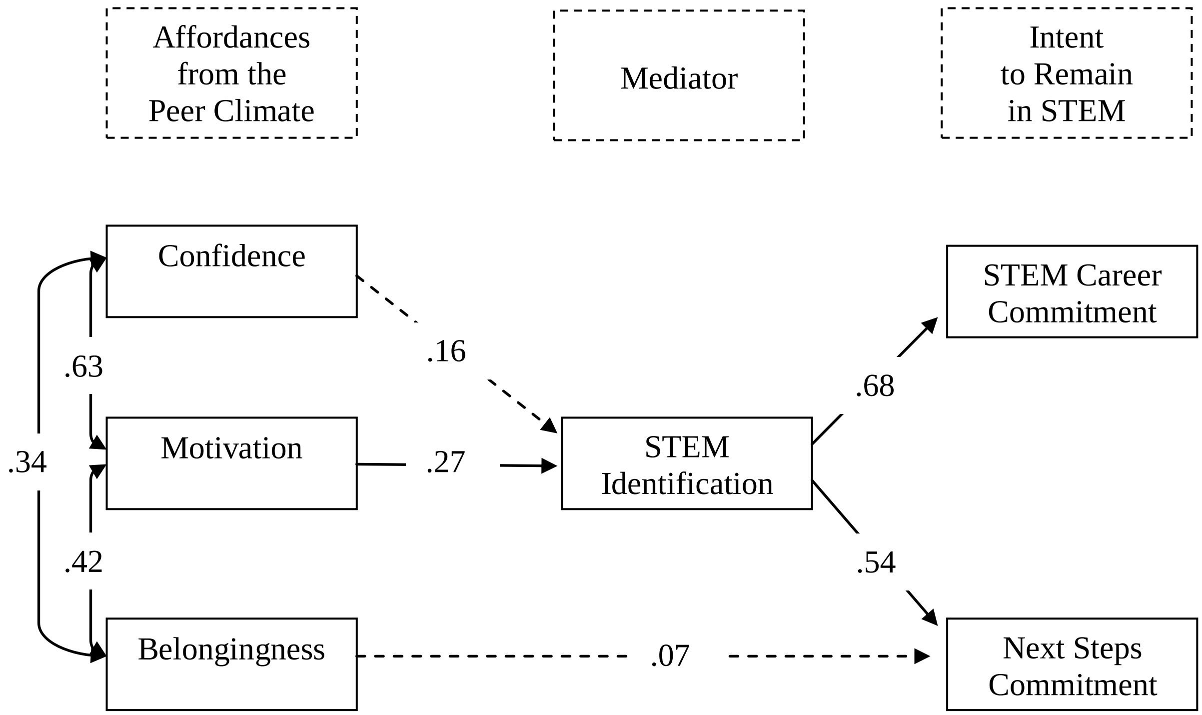

Figure 3. Standardized path coefficients for girls in high school (N = 134). The correlated error term between the commitment variables is not depicted. Paths are significant at the .05 level unless dashed.

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. This indirect path was significant (β = .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.

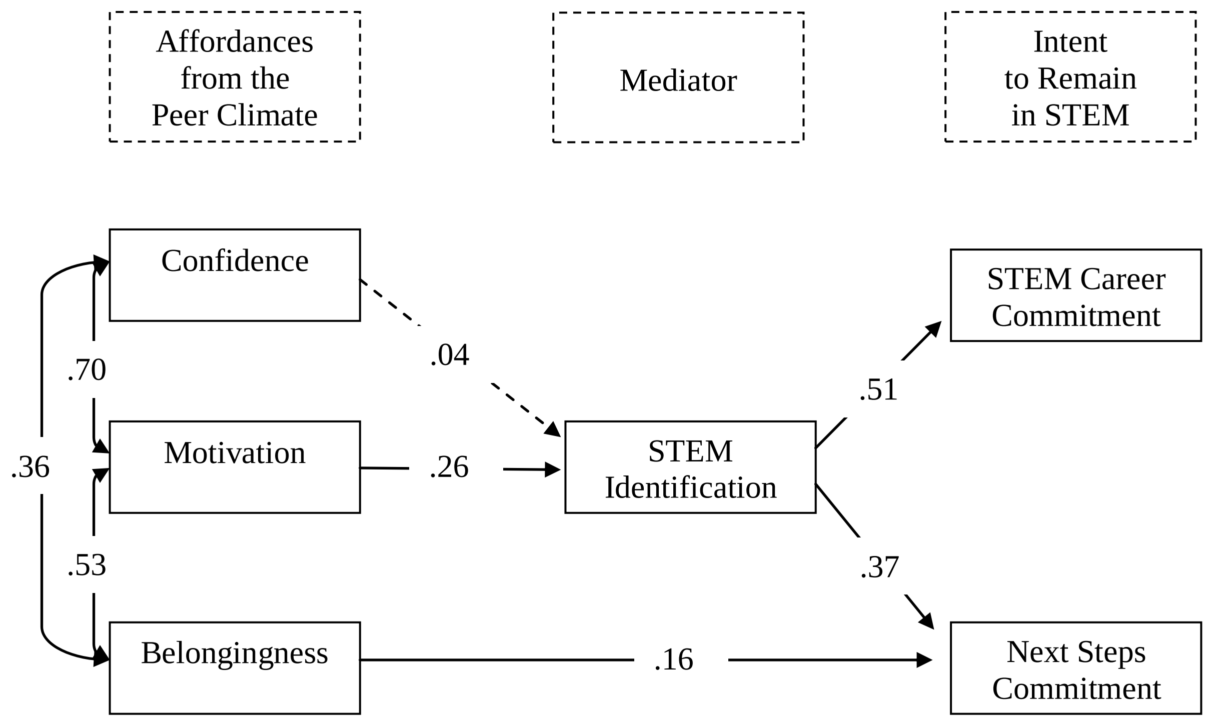

Figure 4. Standardized path coefficients for women in college (N = 125). The correlated error term between the commitment variables is not depicted. Paths are significant at the .05 level unless dashed.

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. Analyses indicated that phase of education did not moderate any of the associations between the peer climate affordances and STEM identification. Thus, Hypothesis 2a, which predicted that links between these constructs would be stronger for participants in graduate school than other participants, 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, which predicted that identity and career aspirations would become more closely fused with increased education, this path was significantly stronger among women in graduate school (β = .70) than it was among women in college (β = .51). It is, however, important to keep in mind that the path was significant for both groups of women.

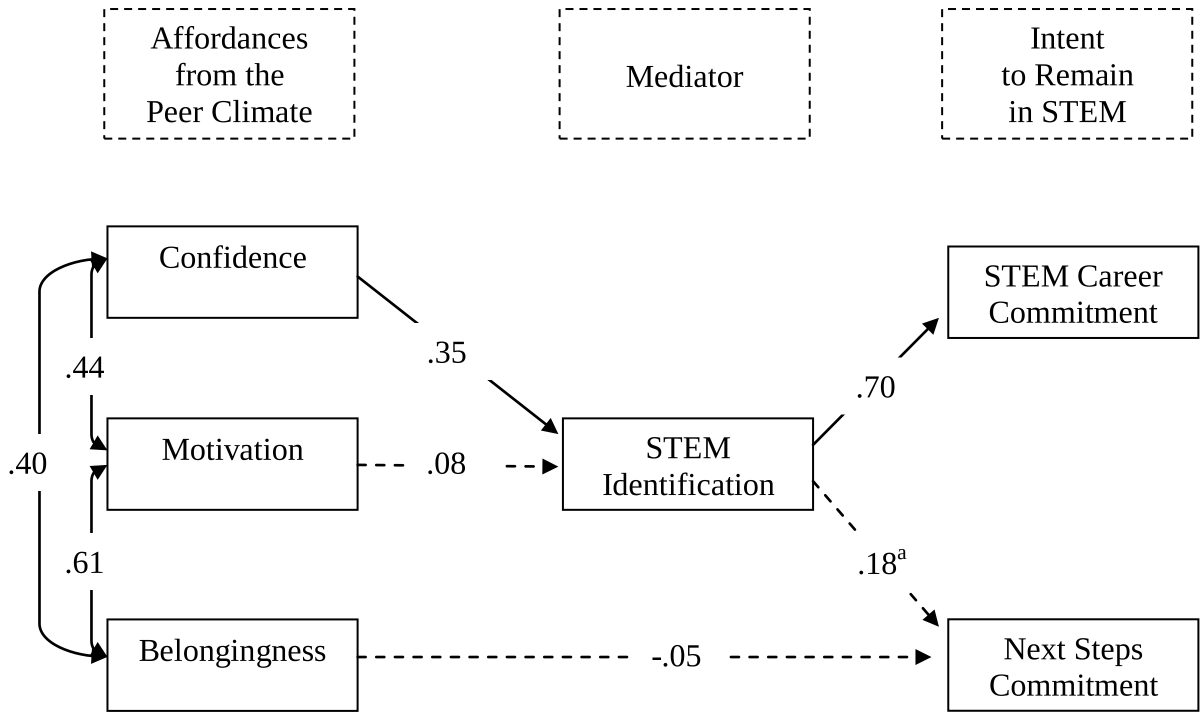

Figure 5. Standardized path coefficients for women in graduate school(N = 102). The correlated error term between the commitment variables is not depicted. Paths are significant at the .05 level unless dashed .[a] Path is marginally significant (p = .078).

DISCUSSION

The present study examined the role peers play in girls' and women's pursuit of STEM careers. Prior research shows that peers can influence students' interest and retention in STEM (Crosnoe et al., 2008; Stake & Nickens, 2005), but 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), it was anticipated that STEM identification may serve this mediational function. That is, the peer climate in STEM was expected to have implications for the extent to which girls and women identify with STEM and, by extension, 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 implies that confidence and motivation statistically outweigh 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.

Overall, these findings 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 peer effects 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 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 students 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 partial 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 at 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 expectations, 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 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. This suggests 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 appointment or tenure-track position in STEM. Tests of mean-level differences in this construct mirrored the leaky pipeline phenomenon: Girls in high school were more committed to the next step than were women in college, and women in college were more committed than were women in graduate school. This is likely because many women who study STEM in college and graduate school leave academia to pursue STEM careers in industry (AAUW, 2010). Relatedly, 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 academia at the graduate level. Consistent with this point, several researchers have argued that perceptions of work-family conflict outweigh most other factors in determining whether or not women in STEM graduate programs pursue careers in academia (see Ceci, Williams, & Barnett, 2009). This suggests that interventions aimed at keeping girls and women in STEM may need to focus on different factors at different phases of education.

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). 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 provide an especially strong test of directionality within mediational models.

The conclusions drawn from the present study would be further enhanced through the use of behavioral outcome measures. Although there is evidence that behavioral intentions are effective predictors of actual behavior within an academic context (e.g., Estrada et al., 2010), this study's findings do not directly speak to this possibility. Thus, examining outcomes such as grades, applications to graduate school, or matriculation to the next phase of education would be a worthwhile direction for future research.

Future research should also examine whether support from female versus male peers yields comparable benefits for girls and women in STEM. Prior research has identified average gender differences in the amount of support that students receive from their peers (Crosnoe et al., 2008; Robnett & Leaper, 2013), but substantially less is known about whether the gender of the support-giver moderates the degree to which support is associated with positive outcomes. For example, perhaps receiving support from male peers is especially beneficial because boys and men tend to have higher status in STEM than do girls and women. Research addressing this question would likely be valuable to both theorists and practitioners who design academic outreach programs.

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. This merits further consideration given that there are ethnic differences in students' pursuit of STEM careers. For example, Asian American girls and women tend to perform better in STEM domains and be more interested in STEM relative to their counterparts from other ethnic groups (AAUW, 2010). Moreover, qualitative research suggests that girls and women from differing ethnic groups can have fundamentally different experiences in STEM fields (e.g., Johnson, 2007). On the other hand, Chemers and colleagues (2011) failed to find ethnicity moderation effects in their test of a model that included several of the constructs used in the present study. Future research should seek to clarify these findings through the use of large, ethnically diverse samples.

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