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Friendship Groups, Personal Motivation, and Gender in Relation to High School Students' STEM Career Interest

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Friendship group characteristics, motivation, and gender were investigated in relation to adolescents' science, technology, engineering, and math (STEM) career interest. The sample was comprised of 468 high school students (M = 16 years, range = 13–18) from diverse ethnic backgrounds. Participants rated their friendship group's support of STEM as well as their personal motivation in science. They separately rated the friendship group's support of English and personal motivation in English. Other predictors included friendship group characteristics (importance, gender composition) and background variables such as gender. Group support of STEM (but not English) and science motivation (but not English motivation) predicted STEM career interest. Group characteristics and participant gender moderated the effects. Findings suggest social identities and self-concepts may shape youths' STEM career choices.

Fields related to science, technology, engineering, and math (STEM) are considered integral to any society's ability to remain competitive in the global economy (Zakaria, 2011), yet the United States will soon experience a critical shortage of workers in these areas (National Science Board, 2003). In combating this shortage, a critical step is identifying factors that promote interest in STEM careers during adolescence. This is an important developmental period to study because adolescents—and high school students in particular—are typically in the process of exploring their occupational identity (e.g., Grotevant & Thorbecke, 1982). Indeed, interests and choices made during high school often lay the foundation upon which subsequent career-related decisions are based (Low, Yoon, Roberts, & Rounds, 2005; Schoon, 2001; Watt, 2006).

The role of gender in STEM achievement and career interest has received wide attention in recent years (for reviews see Ceci, Williams, & Barnett, 2009; Halpern et al., 2007). During high school, girls typically receive better grades than boys in most math and science classes, but boys tend to outperform girls on standardized tests in these subjects (see Halpern et al., 2007; Lindberg, Hyde, Petersen, & Linn, 2010). The gender gap in STEM becomes all the more evident when one considers women's educational and occupational attainment in certain STEM fields (American Association of University Women [AAUW], 2010; National Science Foundation [NSF], 2008). For example, among the doctoral degrees recently awarded in the United States, women only accounted for 15% in physics, 20% in computer science, and 18% in engineering (NSF, 2008). Our interest in gender led us to focus on STEM fields in which women are underrepresented (see American Association of University Women [AAUW], 2010; Diekman, Brown, Johnston, & Clark, 2010; National Science Foundation [NSF], 2008), which meant that we excluded careers in medicine and the social sciences.

Besides gender, other factors that may influence youths' interest in STEM careers include motivation-related self-concepts and social norms. Research guided by the expectancy-value model of motivation (Eccles & Wigfield, 2002) has documented how ability beliefs and values predict achievement in particular domains such as STEM. Furthermore, we proposed that membership in a

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close-knit friendship group that supports STEM would additionally predict students' STEM career interest. Adolescents often look to their close friends and peers to evaluate the kinds of pursuits that they view as possible for themselves. If a student's friendship group values STEM, it may strengthen her or his interest and commitment to a STEM career path. The relations of personal motivation and friendship group characteristics to STEM career interest are reviewed below. In addition, we address how these factors may interact with gender.

PERSONAL MOTIVATION: ABILITY BELIEFS AND VALUES

Motivation-related self-concepts are considered important personal factors related to academic and career aspirations. According to expectancy-value theory (Eccles & Wigfield, 2002; Wigfield & Eccles, 2002), students are motivated to achieve in realms in which they expect to succeed and that they subjectively value. *Expectations for success* refers to individuals' ability beliefs in a particular domain. This construct is similar to self-efficacy in social cognitive theory (Bandura, 1997) and perceived competence in self-perception theory (Harter, 1992). *Subjective task value* refers to personal enjoyment, perceived utility for one's future goals, and the relative importance of one goal over others. Thus, youths' STEM career aspirations are predicated partly on believing that they do well in STEM subjects and on finding these subjects personally interesting and worthwhile.

Previous research clearly indicates that ability beliefs and values are related to academic achievement and aspirations during childhood, adolescence, and adulthood (see Eccles & Wigfield, 2002; Halpern et al., 2007; Hyde & Durik, 2005). With regard to science achievement, for example, DeBacker and Nelson (2000) found that high school students' ability beliefs and interest in science were positively related to their science learning goals. In addition, Schoon's (2001) longitudinal research indicated that academic self-concepts in adolescence predicted STEM career attainment later in adulthood.

Average gender differences in STEM career interest may be partly based on corresponding ability beliefs and values in STEM subjects. On average, girls tend to score lower than boys in ability beliefs and value regarding STEM subjects (Weinburgh, 1995; Whitley, 1997). However, when motivational self-concepts are controlled, average gender differences may be mitigated. Furthermore, as reviewed next, friendship group characteristics may additionally moderate gender-related variations in STEM career interest.

BELONGING TO A FRIENDSHIP GROUP, SOCIAL IDENTITY, AND ACADEMIC GOALS

Friendship Group's STEM Climate

During adolescence, youths tend to affiliate in friendship groups or cliques (Brown, 1990; Rubin, Bukowski, & Parker, 1998). Developmental researchers have observed that belonging to such a group can shape members' thinking and behavior (see Brechwald & Prinstein, 2011; Harris, 1995; Powlishta, 2004). According to social identity theory (Tajfel & Turner, 1986), this occurs because individuals typically look to other group members for social comparison and approval; in turn, identifying with a group can lead to the internalization of its norms and values. Consistent with this explanation, researchers have noted that peers can either bolster or undermine students' academic motivation and achievement (see Azmitia & Cooper, 2001; Ryan, 2000). Accordingly, in the present research, we studied high school students who belonged to a friendship group and examined the extent to which they perceived this group as having a climate supportive of STEM. Although students' perceptions of their friendship group's STEM climate may not be objectively accurate, these subjective representations are nonetheless important because they shape students' STEM-related attitudes and achievement (e.g., Nelson & DeBacker, 2008; Stake & Mares, 2001). Indeed, evidence suggests that adolescents' behavior may be more strongly related to perceived peer norms than to actual peer norms (Prentice & Miller, 1996). We therefore hypothesized that perceived STEM support in the friendship group would predict students' STEM career interest.

We further expected that the association between the friendship group's STEM climate and participants' STEM interest would be domain-specific. Prior research has documented that overall academic norms within the peer group predict students' enrollment in advanced math courses (Crosnoe, Riegle-Crumb, Field, Frank, & Muller, 2008). However, we reasoned that friendship group norms in specific academic subjects may be especially effective predictors of students' STEM career interest. Therefore, we separately assessed participants' perceptions of friends' support of STEM and support of English. Our expectation was that the friendship group's STEM climate would predict students' STEM career interest after controlling for the group's English climate. Such a pattern would point to the importance of domain-specific friendship group norms.

The friendship group's STEM climate may partly underlie average gender differences in STEM career interest. Many children and adolescents continue to hold negative stereotypes about girls in mathematics and science (e.g., Bornholt, Goodnow, & Cooney, 1994; Kurtz-Costes, Rowley, Harris-Britt, & Woods, 2008). Belonging to a friendship group that values STEM may help girls overcome negative expectations or prejudices regarding STEM achievement (Breakwell, Vignoles, & Robertson, 2003; Stake, 2006). Accordingly, we hypothesized that gender differences in STEM career interest would be mitigated when students reported membership in a friendship group high in STEM support.

Other Group Characteristics

In addition to considering the friendship group's STEM climate, we considered other group characteristics as potential moderators. In a recent review, Brechwald and Prinstein (2011) observed that little work has tested peer group characteristics as moderators of peer influences. In the present study, we examined two group characteristics as moderators of the association between the friendship group's STEM support and students' STEM career interest. One moderator is the importance of the group to the individual (also see Cameron, 2004; Smith et al., 1994). For example, Stake and Nickens (2005) found that gifted high school students in a summer science enrichment program were more likely to express interest in becoming a scientist at the end of the program if they experienced stronger and more positive ties to program peers. In the present study, we did not limit our sample to gifted students and we considered adolescents' ties to an ongoing friendship group. We hypothesized that the association between the group's STEM climate and students' STEM career interest would be stronger when students placed greater importance on the friendship group.

A second group characteristic that we considered was the gender composition of participants' friendship group. Prior research suggests that individuals may be more likely to enact gender-typed social norms in same-gender groups than in mixed-gender groups (see Leaper & Smith, 2004; Maccoby, 1998). To the extent that STEM is gender-typed as a masculine pursuit, a higher proportion of same-gender friends may undermine some girls' interest in STEM. However, there is also reason to anticipate that the opposite pattern could occur. For example, research indicates that people's concerns with adhering to traditional gender roles are heightened in mixed-gender social settings because gender becomes more salient (see Deaux & Major, 1987). Thus, it may be that girls' STEM interest is diminished when they affiliate in a mixed-gender friendship group. To explore these alternatives, we tested the proportion of same-gender friends (i.e., gender composition) in the friendship group as a moderator in our analyses.

BACKGROUND FACTORS

In addition to gender, we included other pertinent background factors in our model. First, we controlled for students' age because exploring one's occupational identity is more common in late adolescence than in early adolescence (Grotevant & Thorbecke, 1982; Meeus, Iedema, Helsen, & Vollebergh, 1999). Second, we took into account students' ethnic backgrounds and socioeconomic status (SES). On average, Asian American youth tend to perform better in STEM subjects than do students from other ethnic backgrounds (AAUW, 2008; AAUW, 2010). However, because average ethnic group differences in achievement may be confounded by SES, we additionally controlled for SES by using parents' education level as a proxy (see Davis-Kean, 2005). Finally, we controlled for students' grades because students who are already doing well in science and math may be more likely than other students to consider a future career in STEM.

THE PRESENT RESEARCH

The present study had the following goals. First, we investigated the extent to which personal motivation and friendship group STEM climate predicted adolescents' STEM career interest after controlling for gender and other background factors. We hypothesized that the effects of these variables would be domain-specific, such that the friendship group's STEM climate and students' science motivation would predict STEM career interest after controlling for the friendship group's English climate and students' English motivation.

Given that the link between motivation and career interest is arguably better established than the link between friendship group characteristics and career interest, another important goal of the present study was to examine whether the friendship group's STEM climate would predict STEM career interest after controlling for the science-related motivational factors (i.e., ability beliefs and values). In other words, we expected that the friendship group characteristics would account for a significant amount of variance in participants' STEM career interest above and beyond the variance accounted for by the motivational factors.

Finally, we investigated possible moderation effects. One goal was to examine the extent to which friendship group and motivational variables interact in predicting STEM career interest. In addition, we examined whether friendship group characteristics (friendship group importance and group gender composition) moderate the association between group STEM climate and STEM career interest.

METHOD

Participants

Participants were recruited from five high schools in northern California. The classes included advanced placement and regular levels. The full sample includes 737 participants. However, given the purposes of the current study, our analyses focused on a subset of 468 participants (204 boys, 264 girls) who indicated that they had a group of friends with whom they regularly spent time.

Students ranged in age from 13 to 18 (M = 16.18, SD = 1.18), and the sample was ethnically diverse (51% Asian American/Pacific Islander, 20% European American, 14% Latino/a, and 15% Mixed/Other). Socioeconomic backgrounds were inferred from participants' reports of their parents' highest level of education. Among the mothers, 31% had no higher than a high school degree, 54% had attended at least some college, and 13% had an advanced degree. Among the fathers, 30% had no higher than a high school degree, 52% had attended at least some college, and 18% had an advanced degree.

Participants from the five high schools differed with respect to their self-identified ethnic backgrounds. Participants from two schools that accounted for 74% of the sample predominantly identified as Asian American/Pacific Islander (66%). Participants from a third school that accounted for 14% of the sample predominantly identified as European American (45%) or Latino/a (42%). Participants from a fourth school that accounted for 6% of the sample predominantly identified as European American (63%). Lastly, participants from a fifth high school that accounted for 5% of the sample identified as European American (32%), Asian American (28%), or mixed/other (32%).

Procedure

The survey was titled "What It Means to Be a Student," and it included questions and scales pertaining to the student's background, academic self-concepts, academic achievement, and peer group characteristics. Students were told that their participation was optional, anonymous, and would not influence their grades. A researcher (from among five females and one male) administered the surveys in students' classrooms during periods that ranged in length from 50 to 75 min. Students who had not received parental consent engaged in other activities while the participants completed the survey. Although specific rates of participation are not available, an average of 71% of students across all classes participated.

Measures

Parent education. Participants separately indicated their mothers' and fathers' level of education on the following scale: 1 = *elementary school*, 2 = *some high school*, 3 = *high school*, 4 = *some college*, 5 = *bachelor's degree*, 6 = *some graduate school*, or 7 = *graduate degree*. When participants provided information about both parents, these values were averaged to create a composite parent education variable. Otherwise, the value for the one parent was used.

Self-reported grades. Self-reported grades are generally considered a close index of students' actual grades. In their meta-analysis, Kuncel, Crede and Thomas (2005) noted that self-reported grades and actual grades similarly predict outcome measures. In the present study, participants were asked to indicate the grade that they typically received in different subjects. A list of subjects was provided and students were asked to circle one of the following grades for each subject: *A+*, *A*, *A−*, *B+*, *B*, *B−*, *C+*, *C*, *C−*, and below *C−*. These grades were converted to a 10-point scale (*A+* = 10, below *C−* = 1). Given the importance of math in science achievement, we averaged science and math grades in our analyses. Thus, for the present study, we used students' self-reported science/math grade and English grade.

Science and English motivation. Items from Eccles's expectancy-value model of motivation (Eccles & Wigfield, 1995) were used to measure ability beliefs and value in science and English. All items were rated on a 4-point scale. The expectancy scale included seven items ($\alpha = .85$ for science, $\alpha = .80$ for English). Examples are as follows: "Compared to most other students in your classes, how hard is science [English] for you?" (1 = *Much harder* to 4 = *Much easier*) and "How much effort would you need to do well in an advanced science [English] course?" (1 = *A lot* to 4 = *Almost none*). The value scale was comprised of six items ($\alpha = .85$ for science, $\alpha = .76$ for English). Examples are as follows: "In general, how interesting or fun do you find working on assignments in science [English] class?" (1 = *Very boring* to 4 = *Very interesting*) and "Compared to most of your other activities, how useful is your learning in science [English] class?" (1 = *Least useful* to 4 = *Most useful*).

Friendship group. Participants were presented with the following prompt: "Some people have a few friends who all get together to do things inside or outside of school. Other people have different friends but usually get together with them separately. Do you have a set of friends that you regularly get together with *as a group* to do things?" Participants who responded "yes" were asked to complete the friendship group measures listed below. Participants who responded "no" were asked to skip the section. Given the present study's focus on group processes, we were particularly interested in individuals who reported belonging to a friendship group. This meant excluding some participants who (1) had dyadic friendships that were not part of a larger group or (2) did not have any friends.

Gender composition of friendships group. The gender composition of the friendship group was computed from participants' responses to two questions: "How many girls regularly belong to this group?" and "How many boys regularly belong to this group?" Following each question was a blank line where participants could write their responses. Higher scores indicate a greater proportion of same-gender friends in the group.

Group importance. Group importance was assessed with Cameron's (2004) measures of centrality, ingroup affect, and ingroup ties as well as Smith et al.'s (1994) measure of social integration. *Ingroup centrality* refers to how important the group is to one's identity (e.g., "I often think about the fact that I am a member of this group"). *Ingroup affect* refers to the esteem one derives from group membership (e.g., "Generally, I feel good when I think about myself as a group member"). *Ingroup ties* refer to how closely attached one feels to other group members ("I have a lot in common with other group members"). *Social integration* reflects the extent to which the group functions as a cohesive unit (e.g., "The members of this group are quick to defend each other from criticism from outsiders"). Each subscale was comprised of four items, and each item was rated on a 6-point scale (1 = *strongly disagree* to 6 = *strongly agree*). These subscales were combined to create a composite measure of group importance ($\alpha = .89$).

Friendship group climate for STEM and English. Stake and Mares (2001) designed several measures to assess the impact of peers on students' science interest following a science enrichment program. We used their measures to assess the perceived climate of the friendship group regarding its support of STEM and English. For each subject, we created a composite scale that assessed the group's perceived impact on *motivation* ("Being a member of this group has had a positive influence on my motivation to achieve in math, science, or technology [English]"), *confidence* ("Being a member of this group has made me more confident in my math, science, or technology [English] abilities"), and *establishing a social niche* ("Being a member of this group has helped me to realize that there are others who also enjoy doing math, science, or technology [English]"). There was a total of nine items, and each item was rated on a 6-point scale (1 = *strongly disagree* to 6 = *strongly agree*). Participants completed the measuresseparately for STEM ($\alpha = .84$) and English ($\alpha = .95$).

STEM career interest. Participants rated the extent to which they would enjoy the following seven careers: (1) scientist, (2) engineer, (3) computer scientist, (4) business manager, (5) stage/theater, (6) literature/writing, and (7) careers aimed at helping other people such as health, education, or social services. The occupations were selected to reflect a range of STEM fields and contrasting fields. Participants rated their interest in each career on a scale ranging from 1 (*strongly disagree*) to 6 (*strongly agree*). An exploratory factor analysis indicated that these seven items cleanly loaded onto three factors (all loadings were greater than .65; the highest cross-loading was .27). The first factor included two items: literature/writing and stage/theater. The second factor also included two items: business and helping careers. The third factor included the three items that pertain to STEM career interest: engineer, computer scientist, and scientist. These three careers shared strong correlations with one another (*p*s $< .001$) and weak (or negative) correlations with the other four careers. Thus, participants' ratings of how much they would enjoy a career as a scientist, an engineer, and a computer scientist were averaged to create a composite measure of STEM career interest ($\alpha = .74$). The careers in this composite are among the STEM fields in which women are underrepresented (see AAUW, 2010; NSF, 2008).

RESULTS

Descriptive statistics and Spearman zero-order correlations for all variables are presented in Table 1. Preliminary analyses were conducted to test for possible differences among the five high schools in the STEM-related variables (science/math grades; science ability and value; group STEM climate; and STEM career interest). There were no significant differences.

Hierarchical regression was used to test our hypotheses. All continuous predictor variables were centered to improve interpretability and reduce the likelihood of multicollinearity (Aiken & West, 1991). The VIF in the final model was 2.45, indicating that multicollinearity was not a problem. Sample means were imputed in the case of missing data, which occurred for fewer than 10% of participants across all variables included in the analyses.

The first step of the regression included the following background variables: gender, age, ethnicity, parent education, mean math/science grade, and English grade. Gender was dummy coded (0 = *male*, 1 = *female*). In addition, three categories of ethnicity were dummy coded (0 = *no*, 1 = *yes*) for Asian American, European American, and Latino/a participants. The second step included English motivation (expectancy and value) and friendship group English climate. The third step included science motivation (expectancy and value). The fourth step included friendship group STEM climate, group importance, and group gender composition. The fifth and sixth steps included two- and three-way interactions, respectively.

As seen in Table 2, results of the hierarchical regression revealed that the model was significant at each of the six steps. Furthermore, except for the two-way interactions entered in Step 5, each step of the regression added significantly to the model. Therefore, the model is interpreted at Step 6. At this step, the model accounted for 44% of the variance in STEM career interest. Of particular concern for our primary hypotheses, the science motivation variables (Step 3) added significantly to the model and explained 12% of the variance. Moreover, the friendship group characteristics (Step 4) further added to model and explained an additional 5% of variance. Thus, it appears that friendship group characteristics account for variation in STEM career interest beyond what is accounted for by science motivation. These effects were domain specific in that STEM-related variables explained variance after controlling for the corresponding English-related variables.

In the final model, gender, science expectancy, science value, group STEM climate, and group importance were significant predictors of interest in a STEM career (see Table 2). Specifically, being male, being high in science ability beliefs and science value, and being part of a friendship group high in STEM support independently predicted greater interest in a STEM career. Friendship group importance was a negative predictor of interest in a STEM career, but this predictor is not especially meaningful outside of the context of an interaction with group STEM climate (described later).

The model also contained three significant three-way interactions. The first three-way interaction was for Science Value × Group STEM Climate × Group Importance (see Figure 1). Simple slopes analysis revealed that the combined effects of group importance and STEM climate were especially strong when participants also valued science themselves ($\beta = 1.04$, $p < .001$). In addition, among participants with an important friendship group that did not support STEM, interest in a science career increased significantly as science value increased ($\beta = .46$, $p = .039$). Pairwise comparisons between the four slopes (see Dawson & Richter, 2006) revealed that the slope for participants belonging to an important friendship group that supports STEM was significantly steeper than each of the other slopes (*p*s $< .05$). In other words, as science value increased, interest in a STEM career increased most rapidly among participants with an important friendship group that had a supportive STEM climate.

TABLE 1
Descriptive Statistics and Spearman Correlations Among Variables

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*
1. Gender	—																
2. Asian American	.10*	—															
3. European American	.03	−.52***	—														
4. Latina/Latino	−.06	−.41***	−.20***	—													
5. Age	−.03	−.04	.05	−.01	—												
6. English grade	.17***	.12**	.02	−.15***	.01	—											
7. Science/math grade	.02	.11*	.05	−.19***	−.11*	.47***	—										
8. Parent education	−.05	.00	.22***	−.42***	.03	.19**	.26***	—									
9. English expectancy	.04	−.10*	.11*	.01	.13**	.31***	−.26**	−.05	—								
10. English value	.22***	.15**	−.07	−.04	−.13**	.16**	−.03	.01	.24***	—							
11. Group English climate	.11*	.12*	−.07	−.12*	−.09	.12*	−.02	.04	.10*	.34***	—						
12. Science expectancy	−.13**	−.10*	.10*	−.02	−.18***	.04	.38***	.18***	−.04	−.04	.03	—					
13. Science value	.05	.15**	−.13**	−.11*	−.19***	.10*	.29***	.09	−.17***	.10*	.18***	.37***	—				
14. Group STEM climate	−.10*	.14**	−.14**	−.10*	−.14**	.04	.19***	.00	−.09	.09	.62***	.22***	.43***	—			
15. Group importance	.01	.08	−.08	−.05	−.11*	.00	−.01	.05	.03	.07	.27***	.13*	.07	.27***	—		
16. Gender composition	.01	.02	−.01	−.05	.04	.12*	.10*	.09	−.05	−.04	−.02	−.05	−.03	.01	−.11*	—	
17. STEM career interest	−.34***	.10*	−.13**	−.05	−.09	.05	.22***	.09	−.09	−.07	.12*	.28***	.40***	.43***	−.01	−.02	—
M	—	—	—	—	16.18	7.26	6.95	4.31	2.70	3.07	3.20	2.38	2.75	3.25	4.53	0.72	3.02
SD	—	—	—	—	1.17	1.93	2.06	1.45	0.58	0.55	1.17	0.62	0.64	1.20	0.61	0.23	1.27
Range	—	—	—	—	13–18	1–10	1–10	1–8	1–4	1–4	1–6	1–4	1–4	1–6	1–6	0–1	1–6

Note. STEM = science, technology, engineering, and math. The following variables were dummy coded: gender (0 = *male*, 1 = *female*), Asian American (0 = *no*, 1 = *yes*), European American (0 = *no*, 1 = *yes*), Latina/Latina (0 = *no*, 1 = *yes*). Gender composition refers to proportion of same-gender persons in the friendship group.
$^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$.

TABLE 2
Hierarchical Regression Analysis of Factors Predicting STEM Career Interest

	Step 1 β	*Step 2* β	*Step 3* β	*Step 4* β	*Step 5* β	*Step 6* β
Step 1: Background variables						
Gender	−.35***	−.35***	−.36***	−.30***	−.30***	−.30***
Age	−.09*	−.08	−.02	−.03	−.03	−.02
Ethnicity: Asian	.01	.02	.02	.04	.06	.09
Ethnicity: European American	−.14*	−.13*	−.09	−.07	−.05	.03
Ethnicity: Latino/a	−.05	−.02	.00	.02	.02	.05
Parent education	.03	.03	.02	.06	.05	.07
Mean math/science grade	.19***	.19**	.08	.04	.00	.01
English grade	.01	.02	.04	.05	.04	.04
Step 2: English variables						
English expectancy		−.01	.02	.04	.03	.02
English value		−.06	−.07	−.06	−.04	−.03
Group English climate		.15**	.09*	−.07	−.08	−.09
Step 3: Science motivation						
Science expectancy			.08	.07	.13	.18*
Science value			.33***	.25***	.34***	.28**
Step 4: Group characteristics						
Group STEM climate				.32***	.30**	.32***
Group importance				−.12**	−.09	−.15*
Group gender composition				−.04	−.05	−.06
Step 5: 2-way interactions						
Step 6: 3-way interactions						
Science value × STEM climate × Group importance						.13*
Gender × Science value × Gender composition						−.15*
Gender × STEM climate × Gender composition						.15*
F_{model}	13.63***	11.15***	17.00***	17.35***	8.46***	7.26***
R^2_{change}	.19	.02	.12	.05	.03	.03
F_{change}	13.63***	3.85*	38.93***	13.02***	1.22	2.14*

Note. STEM = science, technology, engineering, and math.
N = 468. All continuous predictor variables were centered. Gender (0 = *male*, 1 = *female*) and the ethnic groups (0 = *no*, 1 = *yes*) are dummy-coded variables. Gender composition refers to proportion of same-gender persons in the friendship group. There were no significant two-way interaction effects in Step 5. Only significant interactions are reported in Step 6.
**p* < .05; ***p* < .01; ****p* < .001.

The second three-way interaction was for Gender × Science Value × Proportion of Same-Gender Friends (see Figure 2). Simple slopes analysis demonstrated that each of the four slopes was significantly different from zero, which indicates that girls were significantly less interested in a STEM career than were boys across each of the four groups depicted in Figure 2 (*p*s < .01). Pairwise comparisons between the four slopes revealed that among participants with a low proportion of same-gender friends, the difference between boys' and girls' interest in a STEM career was less pronounced for participants high in science value ($t = 2.04$, $p = .042$). In fact, out of all the girls in the sample, those who valued science and had a low proportion of female friends were the most interested in a STEM career.

The third three-way interaction was for Gender × Group STEM Climate × Proportion of Same-Gender Friends (see Figure 3). Similar to the interaction described above, simple slopes analysis revealed that girls were significantly less interested in a STEM career than were boys across each of the four groups depicted in Figure 3 (*p*s < .01). Pairwise comparisons between the four slopes revealed that among participants whose friendship group was less supportive of STEM, the difference between girls' and boys' interest in a STEM career was more pronounced for participants with a high proportion of same-gender friends than it was for participants with a low proportion of same-gender friends ($t = 2.83$, $p = .005$). This suggests that having a friendship group that is less supportive of STEM and predominantly comprised of girls may have been especially detrimental to girls' interest in a STEM career.

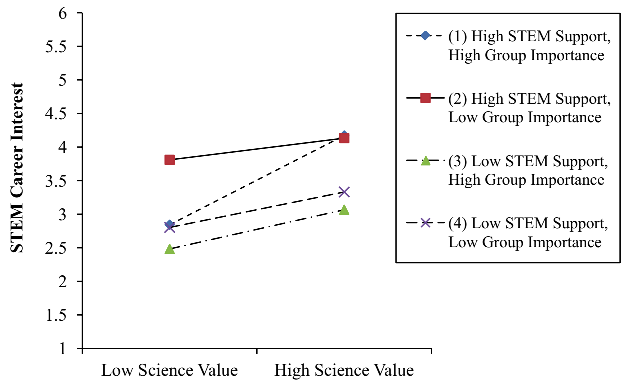

FIGURE 1 Science Value × Group STEM Climate × Group Importance with STEM career interest. STEM = science, technology, engineering, and math.

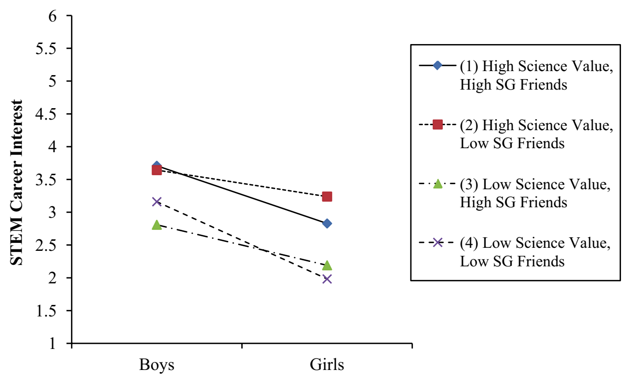

FIGURE 2 Gender × Science Value × Group Gender Composition with STEM career interest. STEM = science, technology, engineering, and math

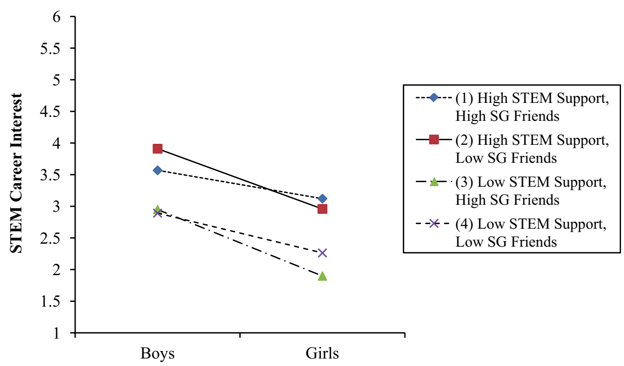

FIGURE 3 Gender × Group Gender Composition × Group STEM Climate with STEM career interest. STEM = science, technology, engineering, and math.

DISCUSSION

In the present study, we examined predictors of youths' STEM career interest. Whereas other investigators have noted that peer group characteristics and motivational factors predict students' STEM interest and achievement (e.g., Stake, 2006), little work has simultaneously considered both sets of factors. Given that there is already research demonstrating that expectancy and value are related to academic aspirations and achievement (see Wigfield & Eccles, 2002), we were especially interested in testing whether the friendship group variables (STEM climate and group characteristics) would independently predict STEM career interest. Therefore, in our analytic model, we tested the effects of the friendship group variables after controlling for the motivation variables. Consistent with expectations, our findings demonstrated that the friendship group characteristics accounted for a significant amount of variance in STEM career interest above and beyond what was accounted for by science motivation. However, it is important to note in the final model that friendship group STEM climate as well as science expectancy and value emerged as significant predictors of STEM career interest.

Another goal of the present study was to examine whether science motivation and friendship group STEM climate would predict STEM career interest after controlling for the corresponding English-related variables. As hypothesized, motivational and friendship group components related to STEM—but not those related to English—were significant predictors at the final step of the model. Such a pattern suggests that there exists a domain-specific relationship between students' STEM career interest and factors such as personal motivation and friendship group characteristics. This finding builds on past research that has linked students' academic achievement in particular subjects to their friends' overall academic performance (e.g., Crosnoe et al., 2008).

With respect to the hypothesized moderation effects, science value qualified the interaction between friendship group importance and the group's STEM climate. Specifically, as science value increased, STEM career interest increased most dramatically among participants who strongly identified with a friendship group that was high in STEM support. Thus, consistent with social identity theory (Tajfel & Turner, 1986), friendship group norms may have their strongest impact when (1) the group's norms are compatible with the individual's own values (Hannover & Kessels, 2004; Ryan, 2000) and (2) the individual has strong ties to the group (Cameron, 2004). To our knowledge, no prior study has taken into account the strength of students' identification with the friendship group when assessing the relationship between group norms and students' academic aspirations. Moreover, as highlighted in Brechwald and Prinstein's (2011) recent review, relatively little research has investigated group characteristics as moderators of peer influence in general.

Main effects indicated that the boys in our study were more interested in STEM careers than were the girls, but two interaction effects indicated that this gender difference may be moderated by social or motivational factors. In one finding, gender differences in STEM career interest were especially pronounced among participants with a friendship group that was low in STEM supportiveness and predominantly comprised of same-gender friends. In other words, girls' STEM career interest was particularly low when their friendship group was primarily female and not perceived as having a supportive STEM climate. Research indicates that friendship groups that are more homogenous in gender composition may be more likely to enforce gender-role norms (e.g., Breakwell et al., 2003). Thus, when a friendship group does not support STEM and is primarily female, girls may find it more difficult to view STEM as compatible with their social gender identity. However, when the friendship group does support STEM, its gender composition may matter less.

Another interaction effect indicated that gender differences in STEM career interest were mitigated when (1) participants were high in science value and (2) members of a friendship group had a low proportion of same-gender friends. For girls who value science, belonging to a mixed-gender friendship group may make it easier to view STEM as gender-neutral (i.e., something that both girls and boys can do). If this interpretation were substantiated in future research, it would call into question the presumed benefits of single-gender over coeducational schooling (see Halpern et al., 2011). However, our observed interaction effect was not predicted and therefore it must be viewed cautiously. Replication and further exploration are warranted.

LIMITATIONS AND FUTURE DIRECTIONS

As with any study, our research had its limitations. We highlight a few issues and suggest corresponding directions for future research. First, the causal relationship between students' academic motivation and the characteristics of their friendship group remains to be delineated. The combined influences of friendship group characteristics and personal motivation have been conceptualized in different ways. For example, in Eccles and Wigfield's (2002) expectancy-value model, a set of antecedent factors is postulated to influence individuals' motivational self-concepts in particular domains. These factors include perceptions of others' beliefs, expectations, and attitudes—which overlap with the social identity constructs underlying the group characteristics that we investigated. In contrast, other theoretical models frame social identity and self-concepts as two interrelated dimensions, whereby one is not necessarily seen as causally antecedent to the other (e.g., Turner, 1985).

Longitudinal research would provide further insight into the links between social identities and motivation. Indeed, a recent longitudinal study demonstrated that friendship group membership appeared to exert an influence on students' academic engagement over time—even after controlling for initial levels of similarity between individuals and the other members of their friendship group (Kindermann, 2007). The finding implies that when students feel ties to a group that supports STEM, their motivation in this domain may be strengthened (Cohen & Garcia, 2008). Of course, students who already value STEM may select friends who share this interest. We suspect that both pathways are likely: Students tend to select friends based on shared interests *and* affiliating with these groups helps to sustain these interests (Kindermann, 2007; Ryan, 2000; Scarr & McCartney, 1983).

A few other directions for future research are worth noting. First, it is important to note that our interest in gender led us to limit our analysis to careers in which women are underrepresented (see AAUW, 2010; Diekman et al., 2010). However, women are increasingly well represented in fields such as medicine and pharmacy (NSF, 2008), which require a strong science background. Hence, it would be fruitful to examine why girls and women gravitate toward some science-related occupations but not others. One important factor may be girls' and women's tendency to prefer occupations that afford opportunities to help others (e.g., Weisgram & Bigler, 2006). It is also important to consider whether social identities and self-concepts have analogous effects on boys' and men's interest in nontraditional careers such as literature and the arts (e.g., Leaper & Van, 2008).

Another question for future research is to investigate whether group STEM support is related to individuals' retention in college majors and careers related to STEM. Many undergraduates who begin in STEM majors later switch to different majors (AAUW, 2010). Students who continue to have friendship groups that are supportive of STEM may find it easier to maintain their motivation and interest. Conversely, students who feel socially isolated in their major may be more likely to seek alternative career pathways (Cheryan & Plaut, 2010; Cohen & Garcia, 2008). Group STEM support may be especially relevant for individuals from backgrounds that are underrepresented in STEM fields (e.g., see Nosek, Banaji, & Greenwald, 2002).

In closing, we note some practical implications of our findings. To the extent that motivation and social identities guide career aspirations, they can become targets for intervention. To increase students' valuing of STEM, it may help if teachers highlight the practical applications and social importance of technical subjects such as physics (e.g., Häussler & Hoffman, 2002; Weisgram & Bigler, 2006). In addition, teachers can address negative stereotypes and discrimination that may lead some students to disidentify with STEM subjects (e.g., Stake, 2003; Weisgram & Bigler, 2007). Lastly, parents and teachers can support girls' and boys' involvement in STEM-related extracurricular programs, which may enhance students' likelihood of befriending peers with similar academic interests (Simpkins, Davis-Kean, & Eccles, 2006). These strategies may lead to greater participation in STEM careers, thereby helping to meet some of society's economic and social challenges (Zakaria, 2011).

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