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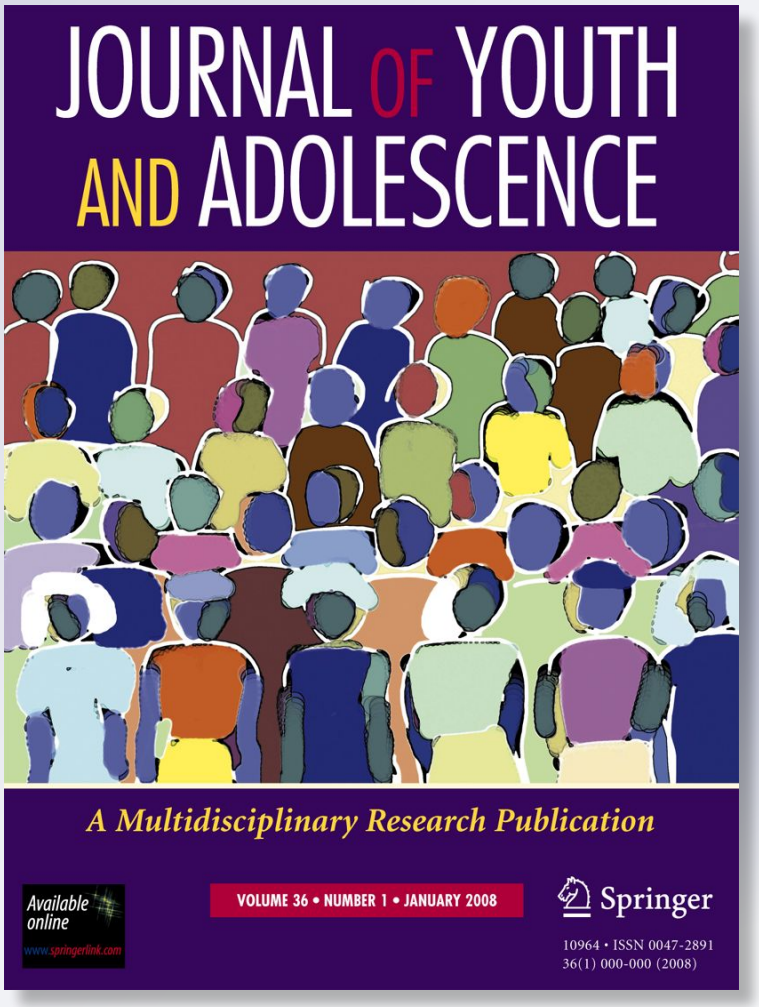
Journal of Youth and Adolescence
A Multidisciplinary Research Publication

ISSN 0047-2891
Volume 41
Number 3

J Youth Adolescence (2012) 41:268-282
DOI 10.1007/s10964-011-9693-z



Springer

J Youth Adolescence (2012) 41:268–282
DOI 10.1007/s10964-011-9693-z

EMPIRICAL RESEARCH

Adolescent Girls' Experiences and Gender-Related Beliefs in Relation to Their Motivation in Math/Science and English

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Received: 4 February 2011 / Accepted: 28 June 2011 / Published online: 16 July 2011

Abstract Although the gender gap has dramatically narrowed in recent decades, women remain underrepresented in many science, technology, engineering, and mathematics (STEM) fields. This study examined social and personal factors in relation to adolescent girls' motivation in STEM (math/science) versus non-STEM (English) subjects. An ethnically diverse sample of 579 girls ages 13–18 years ($M = 15$) in the U.S. completed questionnaires measuring their academic achievement, ability beliefs, values, and experiences. Social and personal factors were hypothesized to predict motivation (expectancy-value) differently in math/science (M/S) and English. Social factors included perceived M/S and English support from parents and peers. Personal factors included facets of gender identity (felt conformity pressure, gender typicality, gender-role contentedness), gender-related attitudes, and exposure to feminism. In addition, grades, age, parents' education, and ethnicity were controlled. Girls' M/S motivation was positively associated with mother M/S support, peer M/S support, gender-egalitarian beliefs, and exposure to feminism; it was negatively related to peer English support. Girls' English motivation was positively associated with peer English support as well as felt pressure from parents; it was negatively related to peer M/S support and felt peer pressure. The findings suggest that social and personal factors may influence girls' motivation in domain-specific ways.

Keywords Academic achievement motivation · Gender identity · Sex role attitudes · Peer relations · Mathematics education · Science education

Introduction

Women have made dramatic advances in the workforce in the past several decades in the U.S. and many other nations. Despite this progress, women are still underrepresented in many fields related to science, technology, engineering, and math (STEM; National Science Foundation 2008). For example, among the recent doctoral degrees awarded in the U.S., women accounted for 27% in mathematics, 15% in physics, 20% in computer science, and 18% in engineering. There is strong evidence that a combination of social and personal factors contribute to gender imbalances in STEM achievement (see Halpern et al. 2007). Social influences include the relative degrees of encouragement that girls may experience to do well in STEM and non-STEM subjects. Personal influences include gender-related variations in self-schemata and attitudes that can shape girls' motivation in STEM or non-STEM domains. The present study examined if and how these social and personal factors are related to adolescent girls' academic motivation in two different domains: STEM (math and science) and non-STEM (English) subjects.

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Expectancy-Value Model of Motivation

The expectancy-value model of motivation was used as a framework for investigating processes related to girls' motivation in STEM (math and science) and non-STEM (English) subjects. According to the expectancy-value model (e.g., Eccles and Wigfield 2002), individuals are motivated to excel in subjects in which they expect to succeed and that they value. Expectation for success reflects the individual's belief about her ability in a particular domain. This component is similar to the construct of self-efficacy in social cognitive theory (Bandura 1997). Value includes the degree of interest and perceived utility that a person associates with a particular subject. Researchers generally find students' achievement is generally lower in subjects in which they do not see themselves as competent (i.e., low ability belief) and that they find uninteresting or useless (i.e., low value).

Whereas girls tend to do as well as boys in math and science grades during adolescence, boys tend to score higher than girls in ability beliefs and value regarding math and science (e.g., Andre et al. 1999; Eccles et al. 1993; Else-Quest et al. 2010; Kurtz-Costes et al. 2008). Gender-related differences in motivation (i.e., expectancy and value), in turn, predict later differences in academic achievement. Thus, gender differences in academic motivation may serve as a key factor contributing to later gender differences in STEM achievement (Halpern et al. 2007).

In the present research, we used a composite measure of motivation that combined expectancy and value. Whereas many studies examine expectancy and value as separate outcome measures, we considered it more parsimonious to combine the measures in our analyses for the following reasons: First, the goal of the present study was to investigate the differential impact of the social and personal predictors on girls' motivation in STEM versus non-STEM subjects. Past research has found that the two components of motivation predict math and science participation among adolescents in similar ways (Simpkins et al. 2006). Our use of a composite measure of motivation may thereby increase the generalizability of any observed effects. Finally, creating a composite outcome measure has the added benefit of reducing the number of effects being tested. Given the number of predictors in our study, the likelihood of Type I error was minimized.

Another analytic strategy in the present study was to average measures of girls' motivation in math and science. Previous studies have taken a similar approach (e.g., Bouchey and Harter 2005; Brown and Leaper 2010; Kurtz-Costes et al. 2008). Both math and science are STEM-related subjects. Also, both math and science have historically been nontraditional subjects for girls (Guimond and Roussel 2001; Halpern et al. 2007). By considering girls' motivation in both subjects, we increase the likelihood that any observed effects apply more generally to girls' motivation in STEM.

We evaluated girls' motivation in English as well as math/science. Whereas math and science have traditionally been masculine-stereotyped subjects, English has been a more feminine-stereotyped subject (Guimond and Roussel 2001; Marsh and Yeung 1998; Stangor and Sechrist 1998). Thus, a comparison between math/science and English could shed light on domain-specific processes that may be related to girls' motivation. The predictors that we hypothesized would differentially predict girls' motivation in STEM and non-STEM subjects are reviewed next.

Predictors of Motivation in STEM and Non-STEM Subjects

The expectancy-value model predicts that both social and personal variables contribute to an individual's motivation in gender-typed domains (e.g., Eccles and Wigfield 2002). Social factors include other people's beliefs and behaviors, whereas personal factors incorporate individuals' self-schemas and perceptions of gender roles. In the expectancy-value model, social factors are proposed to be causally prior to personal factors—with other people's beliefs and behaviors contributing to variation in both individuals' gender self-schemas and gender-role perceptions. In turn, all of these factors contribute to individuals' expectancies for success and valuing of particular subject domains.

We hypothesized that social and personal factors would differentially predict girls' motivation in STEM and non-STEM subjects. The social factors that we focused on were support of math/science (M/S) and support of English from parents and peers. The personal factors that we considered included girls' gender-related identities and attitudes. In addition, we controlled for background factors such as girls' age, ethnicity, and their parents' education level.

The same set of social and personal factors were tested separately as predictors of girls' math/science motivation and English motivation. Prior research indicates that adolescents' motivation varies across different domains (e.g., Wigfield et al. 1991). We correspondingly expected domain-specific effects (described below).

Social Influences: Perceived Academic Support

The expectancy-value model postulates that other people's expectations influence individuals' motivation (Eccles and Wigfield 2002; Wigfield and Eccles 2002). Prior studies indicate that children's perceived academic support from others predicts academic motivation (e.g., Bouchey and

Harter 2005; Frome and Eccles 1998). For example, Frome and Eccles's (1998) longitudinal research found mothers' beliefs about their children's abilities more strongly predicted children's own ability beliefs than did the children's actual grades. In the present study, we considered girls' perceptions of support for M/S and English from mothers as well as fathers. Mothers and fathers may contribute differently in the gender typing process (see Leaper 2002). For example, daughters tend to be closer with mothers than fathers. Also, children may look to same-gender parents for guidance regarding what might be appropriate for their gender.

Research has also highlighted how perceived peers' attitudes toward particular academic subjects are related to individual students' motivation (e.g., Coleman and Hendry 1999; Crosnoe et al. 2008; Stake 2006; Stake and Nickens 2005). For example, Stake (2006) found that encouragement of science achievement from parents and peers was related to more positive attitudes toward science among adolescents. In addition, adolescents were more likely to imagine a future self as a scientist if they had peers who were supportive of science than if they lacked such peers (Stake 2006). Whereas peer support may be important for academic motivation in general, it may be especially important for girls in relatively nontraditional areas such as math and science (Crosnoe et al. 2008).

To summarize, perceiving support from parents and peers for cross-gender-typed domains may strengthen girls' motivation in these domains. In the present research, we examined adolescent girls' perceived support for M/S and English. We hypothesized that perceived support from parents and peers would predict academic motivation in domain-specific ways. That is, we expected that perceived M/S support would predict girls' M/S motivation (but not English motivation), whereas perceived English support would predict girls' English motivation (but not M/S motivation).

Personal Influences: Gender Identity and Attitudes

After controlling for social factors, we tested if two sets of personal variables—gender-related identities and attitudes—might further predict girls' academic motivation. As previously explained, the expectancy-value model proposes that social factors such as others' beliefs and behaviors influence personal factors such as gender self-schemata and perceptions of gender roles. Therefore, in the present study we tested for personal factors after taking into account social factors. In this manner, we could assess whether the personal factors independently added to the prediction of academic motivation. As reviewed below, the personal factors included facets of gender identity and gender-related attitudes.

Facets of Gender Identity

Perry and his colleagues have proposed a model of gender identity consisting of multiple dimensions (Egan and Perry 2001; Tobin et al. 2010). These include gender contentedness, gender typicality, and felt pressure for gender-role conformity. The first of these components, gender contentedness, was originally conceptualized as contentment with one's biological sex. However, the items in the measure appear to better reflect satisfaction with one's *gender role* (Bigler 2006). Accordingly, we shall use the term gender-role contentedness in the present article. We expected that gender-role contentedness, gender typicality, and felt conformity pressure would be related to girls' academic motivation. To our knowledge, there have been no prior studies testing girls' academic motivation in relation to gender-role contentedness, gender typicality, or felt conformity pressure.

First, we expected gender-role contentedness to be negatively related to M/S motivation and positively related to English motivation. As previously reviewed, M/S and English have traditionally been masculine- and feminine-stereotyped subjects, respectively. In addition, there have been corresponding average gender differences in motivation and achievement in these academic areas. To the extent that science and math are viewed as male-dominated domains, girls with stronger motivation in these subjects may be less content with traditional gender roles. Conversely, to the extent that English is traditionally an area in which girls have excelled, girls with strong motivation in this area may be more content with traditional gender roles.

Self-perceived gender typicality is the next gender identity component that we predicted would be related to academic motivation. This construct refers to the degree that a girl considers herself similar to other girls. Prior research has highlighted the impact of social comparison to one's same-gender peers on gender development (e.g., Bussey and Bandura 1999). Also, there is some evidence suggesting that self-perceived gender typicality may be related to academic motivation. Leaper and Van (2008) found that gender typicality was negatively related to undergraduate men's ability beliefs and interest in nontraditional fields as well as their selection of nontraditional majors. We expected an analogous pattern in our sample of high school girls. High gender typicality was hypothesized to predict stronger motivation in the gender-typed domain of English, whereas low gender typicality was hypothesized to predict stronger motivation in the nontraditional domains of M/S.

Felt pressure is the last facet of gender identity that we investigated. This component refers to the degree that girls experience pressures from peers and parents to conform to traditional feminine-stereotyped roles and behaviors. Egan

and Perry (2001) conceptualized felt pressure as a component of gender identity, and we therefore include it with the other gender identity components as a personal factor in our model. Felt pressure might overlap with our aforementioned construct of perceived academic support. That is, a girl who feels overall pressure to conform to traditional gender roles (high felt pressure) may experience support for gender-typed subjects (i.e., English) but not for cross-gender-typed subjects (i.e., M/S). However, felt pressure may encompass a broad range of girls' experiences regarding pressures to conform to gender-stereotyped traits, behaviors, and social roles. For example, concerns with popularity and attractiveness may undermine girls' motivation in nontraditional subjects such as math and science (e.g., Bell 1989). Thus, in the present research we tested whether felt conformity pressures independently predicted academic motivation after controlling for perceived support in particular academic domains. We hypothesized that perceived conformity pressures would be positively related to motivation in English (gender-typed) and negatively related to motivation in M/S (cross-gender-typed).

Gender Attitudes: Egalitarian Beliefs and Learning About Feminism

Gender schemas about the self (i.e., gender identities) and gender schemas about others (i.e., gender attitudes) are independent constructs (e.g., Katz and Ksansnak 1994; Liben and Bigler 2002). Although they tend to be correlated, gender identities and attitudes often differ. For example, a girl might hold gender-egalitarian beliefs about occupational roles, but hold traditional occupational interests herself. In addition, gender identities and attitudes may differentially predict other variables (e.g., Katz and Ksansnak 1994). Thus, among the personal factors in our model, we additionally tested if girls' gender-related attitudes and learning about feminism predicted their academic motivation. Although gender-egalitarian beliefs and awareness of feminism are related, many girls who endorse gender equality may not be aware of sexism and feminism (Brown and Bigler 2004; Leaper and Brown 2008).

There are a few studies that suggest that gender-egalitarian beliefs and learning about feminism may be related to academic motivation. First, Valenzuela (1993) found that holding more egalitarian gender attitudes was related to higher academic achievement in adolescent girls. Second, Leaper and Van (2008) observed college men's endorsement of sexist attitudes was negatively related to their choice of non-traditional majors. Finally, a third study points to the potential benefits of learning about feminism and sexism. Weisgram and Bigler (2007) found that girls' valuing of science increased after learning about the discrimination that women face in science fields. The latter researchers proposed that learning about discrimination helped girls attribute potential obstacles to situational rather than personal factors. Following these prior studies, we hypothesized girls' egalitarian beliefs and exposure to feminism would each be related to stronger motivation in math and science. Because achievement in STEM-related fields remains relatively nontraditional (Halpern et al. 2007), it was expected that egalitarian beliefs and exposure to feminism would be related particularly to motivation in M/S (rather than English).

Controlling for Background Factors

Our study focused on testing the relations of girls' academic motivation to perceived academic support, gender identity, and gender-related attitudes. In addition, we controlled for relevant background factors in our analyses. First, we took into account girls' grades in M/S and English. Not surprisingly, prior research indicates students' grades and academic motivation are typically related (Guay et al. 2003). Second, we included girls' age in the model to control for any age-related changes in academic motivation during the course of adolescence. Past research has found that adolescents' academic motivation (both expectancy and value) tends to decline with age (e.g., Jacobs et al. 2002). Third, we controlled for girls' ethnic background given possible variations in gender socialization practices in different cultural communities (e.g., Raffaelli and Ontai 2004). Finally, we controlled for parents' education due to the possible indirect impact of socioeconomic status on parents' academic support or gender-conformity pressures (e.g., Davis-Kean 2005; Ex and Janssens 1998; Hill et al. 2004).

The Present Study

Predictors of girls' academic motivation (expectancy and value) in M/S and English were investigated. We hypothesized that social and personal factors would independently predict girls' motivation in these subjects after controlling for grades, age, ethnicity, and parents' education. First, perceived support from parents and peers for M/S was expected to positively predict girls' motivation in M/S (but to be unrelated to motivation in English). Conversely, perceived support for English was hypothesized to be positively associated with motivation in English (but to be unrelated to M/S motivation). Second, we expected components of traditional gender identity—felt conformity pressure from parents and peers, felt gender typicality, and gender-role contentedness—to negatively predict girls' motivation in M/S and to positively predict girls'

motivation in English. Finally, we expected girls' gender-egalitarian beliefs and learning about feminism to positively predict motivation in M/S (and to be unrelated to motivation in English).

Method

Participants

The sample included 579 girls recruited from middle schools, junior high schools, high schools, school-related programs, and summer schools in Georgia (9%), northern California (20%), or southern California (71%). Participants ranged in age from 13 to 18 years ($M = 15.2$, $SD = 1.4$). Self-reported ethnic background included Latina (50%), White European American (22%), African American (9%), Asian American (8%), and other/mixed ethnicities (11%). According to the girls' reports, their parents also varied in education level. Among the mothers, 51% had no more than a high school diploma, 36% had attended some college or had a bachelor's degree, and 15% had completed some graduate work or had a graduate degree. Of fathers, 51% had no more than a high school diploma, 30% had attended some college or had a bachelor's degree, and 19% had completed some graduate work or had a graduate degree. The sample was part of a larger study of adolescent girls (see Leaper and Brown 2008).

Procedure

Consent was obtained from each participating student and one parent. Students were administered questionnaires entitled, "What it means to be a girl" by a female researcher in classrooms or similar settings. In addition to demographic questions about the participants' age, grade level, and ethnicity, the surveys included several measures.

Measures

Each of the measures used in the present study are described below. The Cronbach alpha values associated with the internal consistency of items for each scale are presented at the bottom of Table 1 (when applicable). Descriptive statistics for each measure also appear in the same table.

Parents' Education

Participants separately indicated their mothers' and fathers' highest level of education as either: 1 = *elementary school*, 2 = *some high school*, 3 = *high school graduate*, 4 = *some college*, 5 = *bachelor's degree*, 6 = *some graduate school*, or 7 = *graduate degree (master's, doctorate, medical, law, etc.)*. When information about both mothers and fathers was available, their rankings were averaged. Otherwise, we used the value for the parent that was provided.

Academic Motivation

We measured academic motivation separately in math, science, and English/literature (Eccles and Wigfield 2002). The scale for each subject included four items. The two items assessing girls' expectancy (i.e., ability beliefs) were "How good are you at math [science, English/literature]?" (1 = *not good at all*, 2 = *somewhat good*, and 3 = *very good*) and "If you were to list all the students in your year from the worst to the best in each of the following subjects, where would you put yourself?" (1 = *one of the worst*, 2 = *middle*, and 3 = *one of the best*). The two items assessing girls' value (i.e., importance/interest) were "Compared to most of your other activities, how *important* is it to you that you are good at math [science, English/literature]?" (1 = *not at all important*, 2 = *somewhat important*, and 3 = *very important*) and "How much do you *like doing* math [science, English/literature]?" (1 = *not at all*, 2 = *somewhat*, and 3 = *very much*). For each subject, the two expectancy items and the two value items were combined to create a composite measure of motivation. In addition, we averaged scores for math and science.

Academic Grades

Participants reported their typical grades in English, math, science, and other courses. They were asked to circle one of ten possible grades for each subject, ranging from *A+* to *Below C−*, or to circle *Not Taken*. Grades were converted to a numeric scale ranging from 10 = *A+* to 1 = *Below C−*. In the analyses, we averaged math and science grades.

Self-reported grades are generally considered a valid index of students' actual grades. In their meta-analysis, Kuncel et al. (2005) identified large average correlations between self-reported grades and school records ($r = .84$ for math, $r = .82$ for science, $r = .84$ for English). The researchers also noted "it should be kept in mind that self-reported grades generally predict outcomes to a similar extent as actual grades" (p. 76).

Perceived Academic Support

Perceived support in English, math, and science were evaluated separately. Participants were asked, "How much have you personally felt supported and encouraged to do well in English or literature by the following persons?"

Table 1 Spearman bivariate correlations and descriptive statistics

Variables	1	2	3	4	5	6	7	8	9
1. M/S motivation	–								
2. English motivation	.06	–							
3. M/S grades	.68***	.10*	–						
4. English grades	.36***	.51***	.57***	–					
5. Age	−.24***	−.10*	−.41***	−.28***	–				
6. Parent education	.26***	.17***	.42***	.36***	−.34***	–			
7. Mother M/S support	.22***	.14**	.15***	.14**	−.05	.07	–		
8. Father M/S support	.26***	.09*	.28***	.21***	−.16***	.18***	.61***	–	
9. Peer M/S support	.17***	.04	.09*	.04	.03	−.02	.42***	.39***	–
10. Mother English support	.15***	.19***	.14**	.15**	−.05	.09*	.76***	.49***	.39***
11. Father English support	.17***	.13**	.19***	.16***	−.11*	.14**	.52***	.81***	.36***
12. Peer English support	.04	.17***	.00	.07	.05	.00	.35***	.28***	.76***
13. Parental pressure	−.17***	−.01	−.12**	−.06	.10*	−.15***	−.17***	−.25***	−.09*
14. Peer pressure	−.08	−.08	−.02	.00	−.03	.09*	−.13**	−.12**	−.14**
15. Gender typicality	.04	.01	.05	.08*	−.13**	−.03	.15**	.11*	.11**
16. Gender-role contentedness	−.01	−.01	.00	.04	−.03	−.03	.02	.03	−.04
17. Egalitarian attitudes	.25***	.15***	.22***	.18***	−.07	.20***	.14**	.12**	.09*
18. Feminism learning	.17***	.10*	.12**	.12**	.11**	.00	.19***	.17***	.23***
N	592	592	585	581	592	583	551	542	554
M	2.18	2.51	6.01	7.24	15.18	3.58	3.42	3.11	2.86
SD	.43	.46	2.77	2.63	1.39	1.74	.81	1.07	.86
α	.80	.79	NA	NA	NA	NA	.78	.87	.77

Variables	10	11	12	13	14	15	16	17	18
1. M/S motivation									
2. English motivation									
3. M/S grades									
4. English grades									
5. Age									
6. Parent education									
7. Mother M/S support									
8. Father M/S support									
9. Peer M/S support									
10. Mother English support	–								
11. Father English support	.56***	–							
12. Peer English support	.39***	.35***	–						
13. Parental pressure	−.16***	−.23***	−.07	–					
14. Peer pressure	−.11*	−.11**	−.10*	.51***	–				
15. Gender typicality	.11**	.09*	.11*	−.05	−.10*	–			
16. Gender-role contentedness	−.04	.04	−.06	−.08	−.14**	.24***	–		
17. Egalitarian attitudes	.15**	.10*	.11*	−.21***	−.14**	−.27***	−.31***	–	
18. Feminism learning	.18***	.14**	.23***	.01	.01	−.01	−.10*	.10*	–
N	548	535	548	588	588	591	588	575	588
M	3.45	3.10	298	1.84	1.83	2.63	2.12	3.10	5.46
SD	.88	1.10	.94	.81	.67	.64	.66	.43	2.82
α	NA	NA	NA	.87	.73	.79	.76	.67	NA

M/S Math/science, *NA* Not applicable

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

They subsequently rated "mother," "father," and "classmates/friends" on a 4-point scale (1 = *never*, 2 = *a little bit*, 3 = *sometimes*, 4 = *a lot*). (Ratings were also made regarding "teacher" and "anyone else" but these were not used in present analyses.) Similar questions were asked regarding perceived support in math and science. Ratings of perceived math and science support were averaged. In summary, the following measures were used in the analyses: perceived mother M/S support, perceived father M/S support, perceived peer M/S support, perceived mother English support, perceived father English support, and perceived peer English support.

Gender Identity

Egan and Perry's (2001) multidimensional scale for measuring gender identity was adapted to assess the following facets: felt conformity pressure from parents, felt conformity pressure from peers, self-perceived gender typicality, and gender-role contentedness. Items for each of these subscales were rated on a 4-point scale (1 = *disagree strongly*, 2 = *disagree somewhat*, 3 = *agree somewhat*, and 4 = *agree strongly*). Felt pressure refers to perceived demands to conform to traditional gender roles. Four items assessed *felt conformity pressure from parents* (e.g., "My parents would be upset if I wanted to learn an activity only boys usually do"), and 4 items measured *felt conformity pressure from peers* (e.g., "The girls that I know don't like girls who sometimes do things that boys usually do"). *Gender typicality* refers to the extent that the girl viewed herself as typical compared to other girls. Six items from Egan and Perry's survey were used, and they were adapted by adding "at my school" at the end of each statement to establish a clearer reference group (e.g., "I think that I am a typical girl at my school"). Finally, Egan and Perry (2001) included gender contentedness to refer to contentment with one's biological sex. However, we interpret the items as reflecting contentment with one's gender *role*; hence, we use the term *gender-role contentedness* rather than gender contentedness. This facet was assessed using 5 items (e.g., "I feel annoyed that I'm supposed to do some things just because I'm a girl"). Higher scores indicate higher feelings of felt parental pressure, felt peer pressure, self-perceived gender typicality and gender-role contentedness, respectively.

Gender-Egalitarian Beliefs

Questions adapted from the Attitudes toward Women Scale for Adolescents (Galambos et al. 1985) were used to assess girls' gender-egalitarian attitudes. Participants rated 10 items (e.g., "In general, the father should have greater authority than the mother in making family decisions") on a 4-point scale (1 = *disagree strongly*, 2 = *disagree somewhat*, 3 = *agree somewhat*, and 4 = *agree strongly*). Higher scores indicated more gender-egalitarian views.

Learning About Feminism

The directions for this section began as follows: "Feminism refers to the belief in equality for women and men. Feminists believe in equality and point to ways that society and certain individuals treat women and girls in unfair ways…" Participants were then asked to respond (*yes* or *no*) to 10 items assessing their exposure to feminism and feminists. First, they were asked: "Have you learned about feminism or the women's rights movement from any of the following sources?" (a) *books, magazines, or other forms of literature*, or (b) *TV, films, the radio, or the internet*. Next, they were asked: "Have any of the following persons ever talked to you about feminism or the women's rights movement?" (c) *your mother*, (d) *anyone else in your family*, (e) *teachers or coaches*, (f) *friends/classmates*. Finally, they were asked: "To your knowledge, do any of the following persons consider themselves to be feminists?" (g) *your mother*, (h) *any other family members*, (i) *any of your school teachers/coaches*, and (j) *any of your friends/classmates*. Individual scores represented a sum of "yes" responses with a maximum possible score of 10.

Results

Preliminary Analyses

Descriptive statistics and bivariate correlations are presented in Table 1. The bivariate correlations revealed that girls' M/S motivation was positively and significantly related to M/S grade (average of math grade and science grade), English grade, parents' education, parents' M/S support, peers' M/S support, parents' English support, gender-egalitarian attitudes, and exposure to feminism. Girls' M/S motivation was negatively and significantly related to age and felt pressure from parents. In addition, the bivariate correlations indicated that girls' English motivation was positively and significantly related to parents' education level, English grade, M/S grade, parents' English support, peers' English support, parents' M/S support, gender-egalitarian attitudes, and exposure to feminism. English motivation was negatively and significantly associated with age.

In another set of preliminary analyses, two sets of MANCOVAs were conducted to test if there were differences in any of the measures based on girls' ethnic backgrounds. We contrasted Latina girls ($n = 296$), White European American girls ($n = 128$), and other

ethnic-minority groups ($n = 168$). (The latter category was created due to relatively small numbers of girls from ethnic backgrounds other than Latina or White European American.) In addition, parents' education was included as a covariate in these analyses because there were significant differences across the three ethnic groups in parents' education, $F(2, 580) = 269.38$, $p < .001$; $\eta^2 = .48$. Parents' education was significantly ($p < .05$) higher among White European American girls ($M = 5.19$, SD = 1.20) than either Latina girls ($M = 2.40$, SD = 1.17) or other ethnic-minority girls ($M = 4.43$, SD = 1.45); and the latter two groups also significantly differed.

In the first MANCOVA, all of the academic variables were entered: M/S motivation, English motivation, M/S grades, English grades, mother M/S support, father M/S support, peer M/S support, mother English support, father English support, and peer English support. A significant multivariate effect for ethnicity occurred, $F(20, 1{,}000) = 3.66$, $p < .001$, $\eta^2 = .07$. The parents' education covariate was also significant, $F(10, 4{,}999) = 3.81$, $p < .001$, $\eta^2 = .07$. Univariate tests indicated significant ethnic group differences with M/S motivation, $F = 13.43$, $p < .001$, $\eta^2 = .05$; M/S grades, $F = 20.13$, $p < .001$, $\eta^2 = .07$; English grades, $F = 5.41$, $p = .005$, $\eta^2 = .02$; mother M/S support $F = 3.44$, $p = .03$, $\eta^2 = .01$; and father M/S support $F = 8.03$, $p < .001$, $\eta^2 = .03$. Tukey comparison tests indicated White European American girls scored significantly ($p < .05$) higher than Latina girls on these measures (with girls from other ethnic backgrounds scoring in the middle). The ethnicity effect was not significant for English motivation, $F = 2.17$, $p = .11$; peer M/S support, $F = 1.99$, $p = .14$; mother English support, $F = 2.17$, $p = .12$; father English support, $F = 1.61$, $p = .20$; or peer English support, $F = 1.11$, $p = .33$.

The second MANCOVA tested ethnicity as a predictor (with parents' education as a covariate) of the gender identity and attitude measures: felt conformity pressure from parents, felt conformity pressure from peers, self-perceived gender typicality, gender-role contentedness, gender-egalitarian beliefs, and exposure to feminism. There was a significant multivariate effect for ethnicity, $F(12, 1{,}100) = 3.31$, $p < .001$, $\eta^2 = .04$; but not for the parents' education covariate, $F(6, 550) = 1.68$, $p = .12$. Significant univariate effects for ethnicity were indicated with parental pressure, $F = 5.53$, $p = .004$, $\eta^2 = .02$; gender-egalitarian attitudes, $F = 4.68$, $p = .010$, $\eta^2 = .02$; and exposure to feminism, $F = 6.66$, $p = .001$, $\eta^2 = .02$. Tukey comparison tests indicated that felt pressure from parents was significantly lower among White European American girls than either Latina girls or other ethnic-minority girls. Also, White European American girls were more likely to hold gender-egalitarian attitudes than either Latina girls or other ethnic-minority girls. Finally, White European American and Latina girls were more likely than other ethnic-minority girls to report learning about feminism (with no significant difference between White and Latina girls). No significant ethnicity effects were found with peer pressure, $F = 2.03$, $p = .13$; gender typicality, $F = .91$, $p = .40$; or gender-role contentedness, $F = 1.55$, $p = .21$.

In summary, average ethnic group differences were indicated regarding many of the academic and gender-related variables. Parents' education was additionally related to the academic variables. Accordingly, in our subsequent regression analyses, we controlled for girls' ethnic backgrounds and their parents' education. Two ethnicity variables were included and dummy coded as follows: Latina (1 = *Latina*, 0 = *not Latina*) and White European American (1 = *White*, 0 = *not White*). Thus, the first ethnicity variable contrasted Latina girls with girls from all other ethnic groups (White European, Asian American, African American, mixed and other), whereas the second ethnicity variable contrasted White European American girls with all ethnic-minority girls (Latina, Asian American, African American, mixed and other).

Hierarchical Regression Analyses Testing Predictors of Math/Science and English Motivation

Separate hierarchical regression analyses were conducted with math/science (M/S) motivation and English motivation as criterion variables. In both sets of regression analyses, we entered predictors in the following steps: First, *grades* (M/S and English) were entered to control for current levels of achievement when testing the possible association of the other predictors with academic motivation. Second, *background factors* (age, parent's education, and ethnicity) were entered. Third, we tested if the hypothesized *social factors* (mother M/S support, father M/S support, peer M/S support, mother English support, father English support, peer English support) independently predicted academic motivation. The fourth step tested for the possible influences of the *personal factors*. The step included the gender identity (felt parental pressure, felt peer pressure, self-perceived gender typicality, gender-role contentedness) and gender attitudes (gender-egalitarian attitudes, exposure to feminism) measures. Finally, in a fifth step, we tested interaction effects between age and the social/personal variables. The latter step was included for exploratory purposes.

Given that many of the predictors are correlated with one another (see Table 1), collinearity was a potential concern in the regression analyses. Collinearity statistics were therefore performed to assess tolerance levels. Tolerance refers to the percent of variance associated with a particular predictor that cannot be accounted for by the

other predictors. Tolerance values above .10 are generally considered adequate (Chen et al. 2003). The minimum tolerance value in the two regressions was .23, which is within acceptable levels.

Math/Science Motivation

The results from the hierarchical regression testing predictors of girls' M/S motivation are summarized in Table 2. The following steps each significantly added to the model: grades (step 1), background variables (step 2), social factors (step 3), and personal factors (step 4). The 2-way interactions in the fifth step did not significantly add to the model.

Table 2 Summary of hierarchical regression analysis for variables predicting math/science motivation

	Model 1	Model 2	Model 3	Model 4
1. Grades				
M/S grade	.68***	.68***	.66***	.63***
English grade	−.02	−.01	.00	−.02
2. Background factors				
Age		.03	.03	.02
Parents' education		.01	.02	.00
Latina		.09*	.09*	.07
White EA		.10**	.10*	.07
3. Social factors				
Mother M/S support			.18**	.17**
Father M/S support			−.09	−.10
Peer M/S support			.17***	.17**
Mother English support			−.08	−.09
Father English support			.05	.05
Peer English support			−.13**	−.14**
4. Personal factors				
Parental pressure				−.07*
Peer pressure				.02
Gender typicality				.02
Gender-role contentedness				.01
Gender-egalitarian attitudes				.08*
Feminism learning				.08*
F_{model}	244.03***	83.89***	46.75***	32.75***
R^2	.45	.46	.49	.51
F_{change}		2.54*	5.63***	2.90**

$N = 579$, *M/S* Math/science. Ethnic groups are dichotomous variables (0 vs. 1). *EA* European American. A fifth step including 2-way interactions between age and social/personal variables did not significantly add to the model, $F(10, 563) = .36$, n.s.

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

Step 4 was used as the final model. There were seven factors in the model that significantly predicted girls' M/S motivation: M/S grades ($\beta = .63$), mother M/S support ($\beta = .17$), peer M/S support ($\beta = .17$), peer English support ($\beta = -.14$), parental pressure ($\beta = -.07$), gender-egalitarian attitudes ($\beta = .08$), and exposure to feminism ($\beta = .08$). This model accounted for 51% of the variance (with 45% of the variance was explained by the grades entered in the first step).

The following hypotheses were supported: First, social support for M/S predicted girls' M/S motivation. The effect was particularly significant for perceived peer support and mother support. Furthermore, there was evidence of domain-specific effects. That is, mothers' and peers' M/S support was positively related to M/S motivation. Mothers' English support was unrelated to M/S motivation (as expected); and peers' English support was negatively related to M/S support (which was not expected). In addition, our hypotheses regarding felt conformity pressures, gender-egalitarian beliefs, and exposure to feminism were confirmed. Girls were more likely to have strong M/S motivation if they experienced less conformity pressure from parents, they endorsed gender equality, or they had been exposed to feminism.

Contrary to expectation, the other gender identity facets—felt peer pressure, gender typicality, and gender-role contentedness—did not significantly add to the model predicting girls' M/S motivation. None of these variables had been significantly associated with M/S motivation in the bivariate correlations.

English Motivation

The hierarchical regression results testing predictors of girls' English motivation are summarized in Table 3. The steps that significantly added to the model were grades (step 1), social factors (step 3), and personal factors (step 4). Background variables (step 2) and 2-way interactions (step 5) did not significantly add to the model.

The fourth step was treated as the final model. Six variables significantly predicted girls' English motivation in the model: English grades ($\beta = .64$), M/S grades ($\beta = -.31$), peer English support ($\beta = .14$), peer M/S support ($\beta = -.13$), felt parental pressure ($\beta = .08$), and felt peer pressure ($\beta = -.12$). This model accounted for 37% of the variance (with 32% of the variance explained by grades entered in the first step).

As expected, peers' perceived support for English positively predicted girls' motivation in this subject. Unexpectedly, peer support for M/S was negatively related to girls' English motivation. The felt pressure facets of the

Table 3 Summary of hierarchical regression analysis for variables predicting English motivation

	Model 1	Model 2	Model 3	Model 4
1. Grades				
English grade	.67***	.67***	.64***	.64***
M/S grade	−.28***	−.31***	−.29***	−.31***
2. Background factors				
Age		−.02	−.03	−.05
Parents' education		−.02	−.03	−.02
Latina		−.09	−.09	−.10*
White EA		−.02	−.02	−.03
3. Social factors				
Mother English support			.11	.10
Father English support			.08	.08
Peer English support			.15**	.14**
Mother M/S support			.00	.00
Father M/S support			−.09	−.08
Peer M/S support			−.11*	−.13*
4. Personal factors				
Parental pressure				.08*
Peer pressure				−.12**
Gender typicality				−.04
Gender-role contentedness				−.02
Gender-egalitarian attitudes				.03
Feminism learning				.05
F_{model}	138.87***	47.00***	26.42***	18.70***
R^2	.32	.33	.35	.37
F_{change}		1.05	4.27***	2.45*

$N = 579$, *M/S* Math/science. Ethnic groups are dichotomous variables (0 vs. 1). *EA* European American. A fifth step including 2-way interactions between age and social/personal variables did not significantly add to the model, $F(10, 563) = 1.45$, n.s.

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

gender identity dimensions were additionally implicated with diverging patterns for parents and peers. As predicted, when girls experienced conformity pressure from parents, they were more likely to have stronger English motivation. However, unexpectedly, when girls experienced conformity pressures from peers, they were more apt to have weaker English motivation.

Discussion

In the present study, we investigated predictors of girls' academic motivation in math/science (M/S) and English. Our conceptualization of academic motivation was based on the expectancy-value model that emphasizes the combined influences of ability beliefs and value on individuals' achievement in particular domains (Eccles and Wigfield 2002). We hypothesized that social and personal factors would independently predict motivation. The social factors included perceived support from peers and parents in M/S and English; and the personal factors included gender identity and gender-related attitudes. As discussed below, both sets of factors were significant predictors of girls' motivation in M/S and English. Furthermore, these effects were indicated after controlling for girls' grades, age, and sociocultural backgrounds. The findings regarding the latter set of variables are discussed first.

Grades, Age, and Sociocultural Background

When testing for the effects of social and personal factors on academic motivation, we controlled for girls' grades (in math/science and English), age, and sociocultural background factors (ethnicity and parents' education). Girls' age was not a significant predictor of either M/S or English motivation in the regression analyses. Furthermore, there were no interaction effects between age and any of the social or personal factors.

Preliminary analyses indicated significant ethnic differences in academic motivation and achievement. On average, White European American girls scored higher than Latina girls in M/S grades, English grades, and M/S motivation. We therefore controlled for ethnicity and parents' education in the regression analyses. Neither ethnicity nor parents' education were significant factors in the final model with girls' M/S motivation. However, ethnicity remained a significant factor in the regression with girls' English motivation. Latina girls demonstrated lower average English motivation than did other girls. Nonetheless, after controlling for this difference, social and personal factors predicted motivation.

Not surprisingly M/S motivation and English motivation were positively associated with M/S and English grades, respectively. Grades accounted for large percentages of the variance in M/S motivation (45%) and English motivation (32%). At the same time, the social and personal factors that emerged in our final regression models (discussed below) significantly accounted for variance in girls' motivation in M/S and English beyond that already explained by their recent achievement (i.e., grades).

Social Factors and Motivation: Perceived Academic Support

Our hypothesized social predictors of motivation comprised girls' perceived support of M/S and English from

parents and peers. Prior research has highlighted the potential impact of other people's expectations on the development of academic motivation (see Eccles and Wigfield 2002, for a review). We found evidence for the role of domain-specific support in girls' academic achievement. That is, perceived support of M/S (but not English) was positively related to girls' M/S motivation, whereas perceived support of English (but not M/S) was positively related to girls' English motivation.

Girls' M/S motivation was associated with both mothers' and peers' M/S support in the regression analysis. The finding regarding mothers' M/S support is consistent with previous research indicating that children's math achievement was higher when mothers had positive views of their children's math abilities (Frome and Eccles 1998). Our observation that this apparent effect occurred for mothers—but not fathers—may reflect the greater closeness that many daughters have with mothers than fathers (e.g., Smetana et al. 2006). Furthermore, as expected, peer M/S support was important. During adolescence, conformity to peer norms tends to increase (Steinberg and Silverberg 1986). To the extent that science and math remain relatively masculine-stereotyped domains (Guimond and Roussel 2001), girls may find it especially helpful to perceive support among their classmates for achievement in these subjects (Crosnoe et al. 2008; Riegle-Crumb et al. 2006; Robnett and Leaper 2011).

Unexpectedly, girls' M/S motivation was negatively related to perceived peer support of English. In an analogous manner, girls' English motivation was negatively related to perceived peer M/S support. That is, girls who experienced peer support in one domain (e.g., M/S) tended to have weaker motivation in the other domain (e.g., English). Perhaps these results reflect a tendency toward cognitive consistency in girls' thinking (e.g., Baumeister and Leary 1995; Elliot and Devine 1994). Thus, if a girl both (a) has a strong M/S motivation and (b) sees her friends as supportive of M/S, perhaps then she tends to downplay her friends' support of English. Conversely, if a girl's friends emphasize M/S as an important domain of achievement, she may develop a strong motivation in M/S at the expense of English.

A related question for future research is to consider whether some girls experience competing peer subcultures that favor either M/S or English. For example, some girls may have one set of friends who like math and science but dislike English, and they may have another set of friends who like English but not math and science. Depending on the relative importance of the different groups, girls' motivation may be affected more by one group than the other. Alternatively, if both peer groups are important, perhaps they complement one another and strengthen girls' motivation in both academic areas.

Personal Factors and Motivation: Gender Identity

The personal factors in our model included different facets of gender identity and gender attitudes. Our model of gender identity was based on Egan and Perry's (2001) multidimensional framework that includes felt conformity pressures (from parents and peers), self-perceived gender typicality, and gender-role contentedness (also see Tobin et al. 2010). Of these different facets, felt pressure was the only aspect of gender identity that predicted girls' motivation in M/S or English.

Contrary to our hypotheses, gender-role contentedness and gender typicality were not significantly related to girls' motivation in M/S or English. One possible explanation is that, although math and science are relatively gender-typed, girls may not have viewed doing well in high school math and science as incompatible with being a typical girl or with their gender role. This may reflect the increasing acceptance of girls and women in math and science. A related idea is that gender typicality and gender-role contentedness may be more strongly related to girls' motivation in the specific STEM fields in which women remain most underrepresented. Women are now well represented in the biological sciences in college, but they constitute relatively small numbers in the physical sciences and engineering (National Science Foundation, 2008). Future research should examine the link between gender identity and motivation (a) in specific STEM fields and (b) at multiple steps in the STEM pipeline from childhood into adulthood.

Whereas gender typicality and gender-role contentedness were not significant factors, felt conformity pressure was related to academic motivation. With regard to felt pressure from parents, this factor emerged in the final model with English motivation and M/S motivation. The observed patterns were consistent with the premise that English and M/S are gender-typed (e.g., Guimond and Roussel 2001). That is, felt parental pressure was positively related to English motivation and negatively related to M/S motivation. Furthermore, felt pressure from parents independently contributed to girls' academic motivation after controlling for domain-specific support from mothers and fathers. Thus, there may be additional aspects of parents' gender socialization (beyond encouragement of particular academic subjects) that may be related to girls' motivation in these academic subjects. Indeed, Bigler and Liben (2007) highlighted several indirect ways that many parents transmit stereotypical attitudes about whether certain traits, activities, and roles are "for girls" or "for boys."

Felt conformity pressure from peers was also related to girls' academic motivation. In particular, perceived peer pressure was negatively related to girls' English motivation. The direction of the effect was unexpected and seems paradoxical. As previously noted, perceived peer support for

English was positively related to girls' English motivation. Furthermore, in the bivariate correlations, felt peer pressure and perceived peer support for English were positively correlated. Yet, it appears that once peers' English support is controlled, girls may tend to have lower English motivation if they additionally experience conformity pressure from their peers. Gender-typed peer pressures among girls may include downplaying personal agency (Prentice and Carranza 2002), which may undermine girls' motivation—perhaps even in subjects that are valued. Thus, even though English may be viewed positively in these peer groups, achievement motivation may be suppressed. This interpretation is speculative, however, and requires testing in future research.

In summary, gender identity was partly successful in predicting girls' academic motivation. Felt pressure from parents is the facet that was most clearly related to M/S and English motivation. As discussed shortly, other personal factors—gender attitudes and learning about feminism—were additionally related to variations in their academic motivation. Before turning to these findings, however, we suggest four minor revisions for Egan and Perry's (2001) measures of gender identity. Our goal is to strengthen what has proven to be a useful model.

First, when assessing self-perceived gender typicality, we advise specifying a comparison group in the items (cf. "I think that I am a typical girl" vs. "I think that I am a typical girl *at my school*"), which we did in the present study. Second, we recommend separately assessing felt pressure from mothers and felt pressure from fathers when sampling children from two-parent, mother-father families. Egan and Perry's (2001) original items (which we used) measure felt pressure from parents. As we saw when we measured perceived academic support, mothers and fathers may affect girls (and boys) differently (also see Leaper 2002). Third, we advocate reframing gender contentedness as gender-*role* contentedness. Many children may be dissatisfied with the restrictions imposed on their gender role, but relatively few children are unhappy with their gender assignment. Satisfaction or dissatisfaction with gender roles is an important facet of gender identity to consider in our changing society.

Finally, our fourth suggestion is to consider whether felt pressure from mothers, fathers, and peers might be better conceptualized as a social factor rather than a personal factor. On the one hand, felt pressure may be viewed as akin to our construct of perceived academic support, which we considered to be a social factor. On the other had, perceived conformity pressures may be interpreted as reflected appraisals that partly define the individual's identity (e.g., see Harter 2003). If so, perceived academic supports also might be better conceptualized as reflected appraisals and aspects of the person's self-concept (i.e., a personal factor). The latter interpretation would be more consistent with Egan and Perry's (2001) model.

Personal Factors and Motivation: Gender-Egalitarian Beliefs and Learning About Feminism

Another set of personal factors in our model included girls' learning about feminism and their endorsement of gender equality. As hypothesized, these factors emerged as significant predictors of girls' M/S motivation. We did not expect that gender attitudes would necessarily be related to girls' English motivation, and that was indeed the case.

First, girls tended to have stronger M/S motivation if they had previously learned about feminism. This finding corroborates and builds upon previous research that girls who learned about gender discrimination in the sciences were more likely than a control group to increase their self-efficacy in science (Weisgram and Bigler 2007). In an analogous manner, the present study suggests that learning about feminism may help bolster girls' motivation in nontraditional academic domains such as science and math.

Girls were also more likely to have stronger M/S motivation if they endorsed gender equality. This association is consistent with previous research. One study indicated that adolescent girls' gender-egalitarian beliefs predicted higher academic achievement (Valenzuela 1993). In another investigation, college men's gender-egalitarian attitudes (i.e., nonsexist views) predicted their choice of non-traditional majors (Leaper and Van 2008). The present study extends the prior research by suggesting that gender-egalitarian values may help girls overcome traditional views of science and math as male-dominated subjects.

The finding that gender-egalitarian beliefs are related to girls' M/S motivation may seem inconsistent with the result that gender identity was *not* related to M/S motivation. However, according to Liben and Bigler's (2002) dual-pathways model, gender schemas for the self (gender identity) and gender schemas for others (gender attitudes) are independent. The model distinguishes between a personal pathway (whereby gender identities can shape attitudes) and an attitudinal pathway (whereby gender attitudes can shape identities). In the present research, the latter pattern may be implicated. That is, girls' gender-related attitudes predicted their academic motivation. However, given the correlational nature of our analyses, we cannot truly infer the direction that these processes may have unfolded over time. Longitudinal research therefore would help to clarify developmental patterns among these variables.

Conclusion and Future Directions

Although the gender gap has dramatically narrowed in recent decades, women remain underrepresented in many science-related fields (National Science Foundation 2008). The present research focused on social and personal factors

that may strengthen adolescent girls' motivation in math and science. Our findings highlight the potential consequence of domain-specific support. Perceived peer support of math and science (but not English) was positively related to girls' math and science motivation. Conversely, peer support of English (but not math and science) was positively related to girls' English motivation.

Whereas parent support can strengthen motivation in math and science (e.g., Frome and Eccles 1998), peer support may be especially important for adolescent girls. When peers are viewed as valuing math and science, girls may be more likely to perceive these subjects as self-relevant during identity exploration (Robnett and Leaper 2011; Stake and Nickens 2005). To help, parents can encourage their daughters to participate in STEM-related extracurricular programs. By being involved with a small group of peers in these programs, girls may find their interest in STEM is affirmed and nurtured (Barber et al. 2005).

Personal factors also may influence girls' math and science achievement. Learning about feminism and endorsing gender equality were positively associated with girls' motivation in math and science. In contrast, these two predictors were not related to girls' motivation in English. Whereas math and science have traditionally been gender-typed subjects for boys and men, English has been gender-typed for girls and women (Guimond and Roussel 2001). Hence, exposure to feminist and gender-egalitarian attitudes may help to inoculate girls against sexist messages regarding women's achievement in math and science fields (e.g., Weisgram and Bigler 2007).

In sum, the results of the present study point to possible ways to increase girls' motivation in math and science. Because women remain largely underrepresented in many STEM fields, these findings have potentially important social implication. Increasing girls' motivation in STEM could benefit society in two important ways: First, attaining greater gender parity in STEM-related fields would increase women's and men's economic equality. STEM fields constitute 9 of the top 10 college degrees leading to the highest paying occupations in the U.S. (PayScale 2011). In addition, increasing women's as well as men's pursuit of STEM-related jobs is considered critical for any nation to remain competitive in the global economy (Zakaria 2008). Thus, to the extent that every child and adult is able to realize her or his potential, our entire society stands to benefit.

Acknowledgments The research was supported by grants to the first author from the University of California Santa Cruz Academic Senate and Social Sciences Division, and by a grant to the third author from the University of California Los Angeles Center for the Study of Women. The authors are grateful to the girls in Atlanta, Los Angeles, and Santa Cruz for their participation. Also, the authors thank the following: Melanie Ayres and Carly Friedman for their helpful suggestions during survey construction; Agnieszka Spatzier for data coordination; and Bren Michelle Chasse and Nicole Nunez for data entry. Preliminary findings from this study were presented at the Biennial Meeting of the Society for Research in Child Development in Montreal, April 2011.

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