ORIGINAL ARTICLE

The Roles of Perceived Identity Compatibility and Social Support for Women in a Single-Sex STEM Program at a Co-educational University

Lisa Rosenthal · Bonita London · Sheri Robin Levy · Marci Lobel

Abstract Single-sex programs have been implemented in a variety of educational settings to help promote greater engagement of women in STEM fields. However, the mechanisms through which single-sex programs increase women's engagement in STEM fields are unclear. Drawing from research in social and health psychology, we examined two theoretically-guided predictors of women's sense of belonging in their STEM majors and belonging at the university: perceived identity compatibility between being a woman and being in a STEM field, and perceived social support. Participants were 65 racially, ethnically, and socioeconomically diverse women enrolled in a single-sex STEM program at a co-educational university in Northeastern United States. Participants completed online surveys before the start of their first year of college, and again at the beginning of their second year of college. Findings from multiple regression analyses support hypotheses that across STEM women's first or transitional year of college, perceived identity compatibility, perceived support from close others, and perceived support from the single-sex program for STEM women were each independently associated with greater sense of belonging in their major. Additionally, perceived identity compatibility and perceived support from the single-sex program were associated with greater sense of belonging at the university. These findings suggest that perceived support from sources such as single-sex programs and perceived compatibility between one's field and being female may sustain women pursuing training
in nontraditional fields such as STEM. Continued investigation of these factors may elucidate the impact of single-sex programs and inform interventions to increase the retention of women in STEM.

Introduction

Women continue to be underrepresented compared to men in science, technology, engineering, and math (STEM) fields in the U.S. as well as in other countries (NSF 2009). Single-sex programs have been implemented in a variety of educational settings to help promote greater engagement of women in non-traditional STEM fields. However, the mechanisms through which single-sex programs increase women's engagement in STEM fields are unclear. To help address this gap in our understanding of mechanisms, drawing from research in social and health psychology, we examined two theoretically-guided predictors of women's sense of belonging in their STEM majors and their belonging at the university: perceived identity compatibility between being a woman and being in a STEM field, and perceived social support. Participants include racially, ethnically, and socioeconomically diverse women enrolled in a single-sex STEM program at a co-educational university in Northeastern United States. These women completed online surveys before the start of their first year of college, and again at the beginning of their second year of college to assess longitudinally how they perceived the fit between being a woman and being in a STEM major, social support for their choice of major by both close others and their institutional single-sex program, and belonging in

L. Rosenthal (✉) · B. London (✉) · S. R. Levy · M. Lobel
Department of Psychology, Stony Brook University,
Stony Brook 11794-2500 NY, USA
e-mail: lirosenthal@notes.cc.sunysb.edu

B. London
e-mail: bonita.london@stonybrook.edu

their STEM major and at the larger university during their first year of college. While this study focuses on a U.S. sample, the variables under investigation derive from a literature that spans several countries, as detailed below. Thus, the constructs examined should be applicable to understanding processes inherent to all single-sex programs.

Although various contributing factors have been examined, gender disparities in STEM fields seem to be due in large part to the marginalization and bias that women face as students in co-educational STEM environments in numerous countries, including Canada, England, and the United States (see Blickenstaff 2005; Ceci et al. 2009 for reviews). For example, in studies conducted in these countries, undergraduate women in STEM majors often report feelings of isolation, intimidation, and even hostility from male peers as well as male professors, and they often have lower self-confidence in STEM domains than men, despite equal or even higher levels of achievement (e.g., Erwin and Maurutto 1998; Ferreira 2003; Hollenshead et al. 1994; Meinholdt and Murray 1999; Warrington and Younger 2000).

Single-sex classes and programs for STEM women have been implemented in a variety of educational settings from elementary schools through higher education for the purpose of reducing exposure to gender bias and creating supportive academic and social environments (e.g., Brainard and Carlin 1998) to boost STEM engagement of women. Even within co-educational schools, exposure to targeted single-sex environments may hold some benefits for STEM women, for example, by reducing exposure to gender bias and feelings of alienation often reported in traditional co-educational programs. However, there has not been overwhelming evidence of whether or through which mechanisms single-sex educational programs or single-sex classes within co-educational schools promote engagement of women and girls in STEM, as reviews of the literature to date offer mixed conclusions (e.g., Protheroe 2009). Reviewers have lamented the difficulty of drawing conclusions about single-sex educational environments (e.g., lack of random assignment, lack of systematic evaluation; see Protheroe 2009). Indeed, some of the largest reviews of the literature focus on limited comparisons between single-sex environments only. For example, an extensive review conducted by the U.S. Department of Education (Mael et al. 2005) excluded studies of single-sex classes in co-educational schools, although this type of setting constitutes a significant amount of the existing single-sex educational environments. Given some evidence of the benefits of single-sex programs in single-sex environments, it may be useful to determine whether those benefits persist when the larger institutional context is co-educational.

Across reviews, a common conclusion is that many studies examining these different educational environments lack sufficient attention to important variables identified by relevant theoretical perspectives (e.g., AAUW 2004; Campbell and Wahl 1998; Smithers and Robinson 2006). Further, the variability in success outcomes of women in STEM fields warrants a critical focus on the processes through which STEM engagement occurs within women. For example, while many women may withdraw from STEM fields at various levels of achievement, some women remain in STEM disciplines and achieve high levels of success. Thus, it is important to examine single-sex programs with a focus on the theoretical mechanisms and processes through which these programs may be working.

Building on relevant theoretical advances from social, health, and developmental psychology, we sought to explore the importance of two psychosocial factors hypothesized to be critical in women's psychological engagement in STEM over time: (1) perceived compatibility between being a woman and being a STEM student, and (2) perceived social support during the pursuit of one's STEM career. In the present investigation, we examined the utility of these two main factors in predicting engagement in STEM and at the university across the first year of college with two cohorts of racially, ethnically, and socioeconomically diverse women who are all enrolled in a single-sex Women in Science and Engineering (WISE) program at a co-educational university. Specifically, with longitudinal data we examine associations of perceived identity compatibility between being a woman and being in a STEM major as well as social support from both close others and the WISE program with engagement in one's STEM major and at the university across women's first or transitional year of college. We operationally define engagement as the extent to which women feel a sense of belonging or fit with their STEM major and university. In the next sections, we briefly elaborate on study variables, the WISE program in which the women in this study are enrolled, and on the importance of examining these particular psychological variables among college women during their first or transitional year in their chosen STEM field.

Perceived Identity Compatibility Between Gender and STEM Major

Drawing primarily from social identity theory from social psychology, we highlight the importance of STEM women perceiving compatibility between their gender and their STEM fields. Social identity theory (e.g., Hogg and Abrams 1988; Roccas and Brewer 2002; Tajfel and Turner 1979) suggests that people develop multiple, nested social identities based on their group affiliation (e.g., identities related to their careers, gender, race, socioeconomic status), and that different social contexts (e.g., STEM classes) elicit thoughts, goals, and behaviors consistent with these identities (e.g., Exline and Lobel 1997; London et al. 2005). For women in the U.S. and

many other countries, societal stereotypes that are often salient in social and academic contexts communicate an incompatibility between being a woman and being in a STEM field (e.g., Eccles 2005). Perceiving an incompatibility between one's gender and STEM identity can be a significant impediment to sustained achievement and engagement in pursuing a STEM career for women over time. Women who perceive an incompatibility between their gender and STEM identity experience heightened stress, tend to doubt their ability to perform, develop negative achievement expectations, and indeed report lower performance, despite previous success in their area of study (e.g., Ancis and Phillips 1996; Settles 2004).

For example, Settles et al. (2009) found greater perceived identity interference among women scientists in the U.S. to be associated with higher levels of depressive symptoms and lower reported performance in science concurrently, and also 2 years later. Thus, perceived identity incompatibility can stir doubt about women's ability to be successful in STEM fields and negatively affect their psychological well-being and engagement in STEM contexts in which such threat is perceived (e.g., Settles 2004; Steele et al. 2002).

Alternatively, when people perceive greater compatibility or less conflict between two or more identities (referred to in the social identity literature as "merger," Roccas and Brewer 2002), they may be free to pursue their STEM education and career without the psychological costs associated with identity conflict. In an experimental manipulation of identity, Shih et al. (1999) demonstrated that among Asian American women, making salient the compatibility (being Asian) versus incompatibility (being a woman) of one's self identities with a math identity led to increases and decreases in women's math performance, respectively. Building on findings from the social identity literature, we suggest that greater perceived compatibility between important social identities (i.e., gender and STEM identity) should be associated with greater engagement in women's STEM field.

Social Support

We suggest another related yet distinct facilitator of engagement is perceived availability of academic, social, and psychological social support resources to help women successfully maneuver obstacles to their pursuit of STEM majors and careers. Research on stress and coping from social and health psychology suggests that the impact of a stressor depends critically on the effectiveness of the coping strategies employed to deal with that stressor (e.g., Lazarus and Folkman 1984; London et al. 2005). The stress associated with perceptions of bias and threat in a particular domain have been related to low levels of social support

and also to declines in mental and physical health in students (e.g., Dunkel-Schetter and Lobel 1990; Gall et al. 2000; Ruble and Seidman 1996). However, the presence of sufficient external coping resources reduces stress-related impediments to engagement in STEM and other academic fields (e.g., Dunkel-Schetter and Lobel 1990; Lazarus and Folkman 1984; London et al. 2005).

One important coping resource identified by social and health psychologists is perceived social support from close friends and family members, such as parents and siblings. For example, Garmezy (1991) suggested that the support received from family members serves as a protective factor in academically challenging environments. Social support resources can also come from within the academic environment, including mentoring relationships that provide exposure to exemplars of the STEM identity (e.g., women in the same fields undergraduates are pursuing), and support groups that boost comfort and sense of belonging within STEM environments (cf. Taylor and Lobel 1989). Further, social support resources from both within and outside the academic environment may serve as important socializing agents in determining which fields of study to pursue, and how to balance multiple demands of life and academics over time.

Consistent with the social support literature's emphasis on the strength of perceived support in buffering stress better than actual support received (see Dunkel-Schetter and Bennett 1990), we focused on measuring perceived social support. Therefore, we propose that women's perceived social support can counteract the demands of pursuing study in traditionally male-dominated fields and thus be associated with greater engagement in their STEM fields and at the university. Specifically, we were interested in examining different sources of social support, including close others (i.e., close friends and family) as well as institutional support that comes directly from a single-sex STEM program for female undergraduates in a co-educational U.S. college environment.

Psychological Engagement

Psychological engagement has been defined and operationalized in a variety of ways including the sense of fit, comfort, motivation and respect individuals feel within a given context (see London et al. 2011 for a review). Past work suggests that sense of belonging, or feeling like one is accepted and fits in well in the STEM major environment or university, is a key indicator of psychological engagement in academic settings, including academic and social adjustment (e.g., Ostrove and Long 2007). Research spanning elementary through college-aged students has demonstrated the link between sense of belonging and adaptive engagement outcomes (e.g., Eccles, et al. 1993;

Goodenow 1993; Osterman 2000; Walker and Greene 2009). For example, in a sample of High School students in the Midwestern United States, Walker and Greene (2009) linked sense of belonging in the academic environment to academic engagement including the adoption of cognitive strategies for achievement and mastery goals. Finn (1989) demonstrated that when sense of belonging was absent, students were more likely to exhibit maladaptive behaviors including school dropout and truancy. Given the established links between sense of belonging and a wide variety of engagement outcomes, we adopted this operationalization of psychological engagement in the current study by assessing perceived sense of belonging within the STEM major and in the university at large (see London et al. 2011; Mendoza-Denton et al. 2002).

The Women in Science and Engineering (WISE) Program

To examine the utility of perceived identity compatibility and social support in predicting engagement in STEM, we chose to study a racially, ethnically, and socioeconomically diverse group of women enrolled in WISE, a single-sex program at a co-educational university that provides female STEM majors with experiences and resources (mostly in their first year of college) aimed at increasing the likelihood that they stay in their chosen STEM field and pursue graduate school and a career in that field. The program is housed in a midsized, publically funded co-educational University in the Northeastern U.S. Our primary hypothesized predictors of engagement—identity compatibility and social support—are particularly relevant in this context. For example, the WISE program is likely to provide frequent and consistent reminders of gender and STEM identity compatibility through exposure to female models of STEM success, and a unique source of social support from other STEM peers and professionals.

The WISE program, established in 1993 with funding from the National Science Foundation to increase the number of women in STEM fields, enrolls approximately 35–50 first-year female STEM students each year and implements both formal and informal academic and social programming. Program elements include financial support exclusive to WISE women students, social and academic events specifically for WISE women, some single-sex courses, and mentoring from female STEM peers, staff, and faculty. For example, all WISE students are required to take a select set of courses that only enroll other WISE women during their first year of college, including a specially-designed WISE section of a more general introduction to the university mandated for all first year students. First-year WISE students also take a required research course open only to WISE women undergraduates— during which they rotate through a variety of STEM research

labs at the university, gain early exposure to STEM research, and conduct brief hands-on studies under the supervision of STEM faculty and graduate students. WISE students are also given preferred registration in other STEM courses, resulting in a number of WISE women peers taking other classes together.

The WISE program provides WISE students with access to exemplars of the female STEM identity through connections with other WISE students, female STEM graduate students, and female STEM faculty members. WISE students meet regularly for mandatory meetings with members of these groups, and particularly every first-year WISE student is required to meet with a mentoring and study group led by an advanced WISE student. The mentoring groups allow WISE women to both give and receive academic advising and support through social networking opportunities that provide an enriching and supportive experience for both the mentors and mentees. The mentors are also available informally through other channels (e.g., electronic mail, telephone) continually throughout the first year of college for the WISE women. The WISE program also requires their students to attend some more formal events such as workshops and colloquia that are exclusively for WISE women undergraduates, and provide information about STEM careers and interactions with women in STEM fields. Taken together, the WISE program attempts to create a supportive and rigorous single-sex STEM program within a co-educational university. However, because of limited financial and other resources, most WISE initiatives are available only to first-year students. The limited resources are primarily directed to the first year of college since this transitional year has been identified as a high-risk period for women in STEM, as elaborated in the next section.

The Transition to College in a STEM Major

According to ecological and transition theories from developmental and social psychology, as people enter new academic and social environments, participate in new activities, or begin new life phases, their goals, expectations, identities, fears and doubts are paramount and can influence how they perceive, experience, and negotiate the environment both in the short-term and in the long-term (Bronfenbrenner 1979; Deaux and Major 1987; Dunkel-Schetter and Lobel 1990; Eccles 2005; Levy et al. 2005; London et al. 2005; London et al. 2007). The transition to college is one such critical period for developing engagement, yet it is also a time when one may question one's abilities, fit, and potential for success (London et al. 2005; Mendoza-Denton et al. 2002). Eccles' work has been instrumental in demonstrating the importance of life transitions within the context of gender and careers (see Eccles 2005 for a review) and has highlighted that a key

factor in maintaining engagement is the fit between the academic environment and the needs of students at particular stages in their academic trajectory (Eccles et al. 1993).

Taken together, these studies suggest that the transition to college is a critical period of academic and social development and that engagement may be determined by the extent to which the collegiate environment meets those developmental needs of students. Throughout college, the commitment and sense of belonging one feels in a STEM major may wane or expand as new challenges and stressors are encountered. For example, during the first year of college, the difficulty of STEM courses may leave some students feeling incompetent and having low confidence in their ability to continue in STEM fields. Students may question their belonging in their STEM major as they encounter both positive experiences that affirm their place in the major, and negative experiences that undermine their engagement (e.g., Eccles 2005; Eccles 2007). Past work has shown that women's feelings of self-doubt, anxiety, and discouragement in STEM fields in places like the U.S. and Canada often appear within the first or transitional year of college (e.g., Brainard and Carlin 1998; Erwin and Maurutto 1998), and many of the college women who choose to drop out of STEM majors do so during their first year (e.g., Brainard and Carlin 1998). Drawing on past work, we suggest that for women in STEM fields, the negative impact of these transitions can be reduced by perceiving greater compatibility between being a woman and being in a STEM major, and perceiving greater social support to reduce self-doubts and stress (London et al. 2005), and that these two variables are key in predicting women's engagement in their STEM major during the transition to college.

Overview of Hypotheses of the Present Investigation

First, we examined the pattern of change across the first year of college in the variables of interest, using repeated measures analysis of variance (ANOVA) analyses. Based on research and theory reviewed above noting the challenges associated with transitions, especially in the context of women entering fields in which they have been traditionally marginalized and underrepresented, our first hypothesis was that perceived identity compatibility, perceived social support, and sense of belonging would each decline from the start of college to the start of the second year of college. Next, we examined associations of perceived identity compatibility and perceived social support with sense of belonging in one's STEM major and at the university, using regression analyses in which previous achievement (operationalized as High School grade point average: GPA) was controlled and perceived identity compatibility and perceived social support from close others

and from the single-sex program were entered as simultaneous predictors. Based on research and theory emphasizing the importance of these variables, our second hypothesis was that perceived identity compatibility and perceived social support from close others and the single-sex program would be associated with greater sense of belonging in one's STEM major. Third, because women's perceptions and experiences in their major likely map onto their perceptions of how welcoming the university environment is in general (e.g., Hoffman et al. 2002; London et al. 2005; Mendoza-Denton et al. 2002), we also expected perceived identity compatibility and perceived social support from close others and the single-sex program to predict sense of belonging at the larger university environment across women's first year of college. We expected that perceived identity compatibility and perceived social support would each contribute uniquely to predicting sense of belonging, both in STEM and at the university more generally. We additionally conducted an exploratory analysis to determine whether the associations examined might be moderated by race/ethnicity or family income, two factors that have previously been associated with academic disengagement, although the number of participants in each subgroup was not sufficiently large to provide strong tests.

Method

Participants

Participants included in all analyses were 65 women enrolled in the single-sex WISE program at a co-educational, mid-sized state university, Stony Brook University. These women were invited to enroll in the WISE program after successful completion of a competitive application process based on their high school academic performance, particularly in science and mathematics classes; standardized test scores; demonstrated interest in STEM fields as evidenced by extracurricular activities or other experiences; recommendations from their High School teachers and/or mentors; and their own goals and aspirations as expressed in a required essay. The WISE program focuses on applicants who are accelerating directly from high school to college. In addition, in an effort to form a diverse group, race-minority, recent immigrant, and first-generation applicants are recruited through program contacts within regional high schools.

Consistent with the incoming cohorts of prior WISE women, study participants' High School GPAs were high, with a mean of 94.72 on a scale of 100 ($SD=3.54$; $Range$ 86–100). Mean age of participants at the start of the study was 17.71 ($SD=.61$; $Range$ 16–19; $Mode$ and $Median=18$). Participants were from diverse racial and ethnic backgrounds, with 24 identifying as European American or White, 15 as East Asian, 14 as South Asian, 5 as African

American or Black, 3 as Latino or Hispanic, and 7 as Other or Mixed. Twenty-five percent of the sample reported that English was their second language, and 32% reported being born in a country other than the U.S. The participants were also diverse in terms of family income, with 4 reporting family incomes of less than $10,000; 16 between $10,001 and $50,000; 24 between $50,001 and $100,000; 17 between $100,001 and $200,000; and 4 more than $200,000. Participants' majors varied within STEM fields, including Applied Mathematics and Statistics, Biology, Biochemistry, Biomedical Engineering, Chemistry, Computer Science, Mechanical Engineering, and Physics.

Prior to the start of classes in the first semester of their first year of college, we contacted participants by electronic mail to invite them to participate in the longitudinal study. If they were interested, they first completed a Web-based consent form, and then continued on to complete the first, background survey. Participants were paid $15 for completing a questionnaire days before beginning classes at the university (Fall background survey—Time 1), and $20 for completing a questionnaire during the first week of the Fall semester of their second year (Fall follow-up survey—Time 2).

Attrition

The study began with 96 women who were recruited before the beginning of classes in the Fall semester of their first year in college to complete a background questionnaire. One year later, at the beginning of the Fall semester of their second year, 66 of the original 96 completed the follow-up survey (loss of 30 participants, or 31%). This rate of attrition is roughly consistent with rates of attrition found in other longitudinal studies with college students (e.g., Settles et al. 2009). It should be noted that we also removed from subsequent data analyses one participant who completed surveys at both time points but left her STEM major to switch to Psychology; thus the sample size for all analyses was 65 participants. A series of t-tests comparing the 65 participants included in all analyses to the other 31 who completed only the first time point revealed no significant differences on any of the predictor or outcome variables assessed at Time 1 in this study, including High School GPA and age.

Procedure

Participants were selected for recruitment for the longitudinal study based on their status as first year college students enrolled in the WISE program at the university. Participants were contacted by electronic mail 1 week before the beginning of their first semester in college and given the link to the online background survey (Time 1). During the first week of the Fall semester of their second year, participants were again sent links by electronic mail to the follow-up online survey

(Time 2). All surveys could be completed from any computer with Internet access, and participants' data were linked using their Unique Login ID, which they created.

Measures

Demographics

For the background survey (Time 1), participants provided demographic information (age, gender, race/ethnicity, country of birth, and first language) and family income based on a 5-point scale (1=less than $10,000; 2=between $10,001 and $50,000; 3=between $50,001 and $100,000; 4=between $100,001 and $200,000; and 5=more than $200,000), as well as their High School GPA and intended major in college.

Compatibility Between Gender and Major

To examine compatibility between gender and major, we selected a commonly and well-established pictorial measure of compatibility or integration, the "Inclusion of Other in the Self" measure, which has been used across many domains (e.g., Aron et al. 1992; Tropp and Wright 2001). This measure is easy for participants to grasp and evaluate, and requires only one item, demonstrating levels of test-retest reliability and convergent and predictive validity that are as good as or better than lengthier measures. At both time points, participants selected the pair of progressively overlapping circles out of 7 choices that they believe best represented the connection or compatibility between their gender (represented by one of the circles) and their STEM major (represented by the other circle).

Support From Close Others

At both time points, participants completed a 5-item measure designed for this study of perceived social support for one's major from close others. Participants rated on a scale of 1 (Very unsupportive) to 7 (Very supportive) how supportive of their choice of major various close others in their lives were, including their mother, father, siblings, other close relatives, and friends. Participants had the choice of marking "N/A" if one of the items was not applicable to them (e.g., has no siblings). A mean score of all five items (or fewer if one of the items was inappropriate for a participant) was computed to create a composite scale. At both time points, the measure demonstrated good internal reliability (Cronbach's Alphas≥.86).

Support From WISE Program

At Time 2 only, participants completed two items to measure perceived social support for one's major specifi-

cally from the WISE program. Similar to the measure for support from close others, participants rated on a scale of 1 (Very unsupportive) to 7 (Very supportive) how supportive of their choice of major other WISE students, and WISE staff and faculty were. A mean score of the two items was computed to create a composite scale. The measure demonstrated good internal reliability ($r=.79$).

Sense of Belonging in STEM Major and at University

As a measure of engagement in one's STEM major, at both time points participants completed an 8-item sense of belonging in STEM major scale, adapted from Mendoza-Denton et al.'s (2002) Institutional Belonging Scale. The measure included questions about one's major in general, about professors in their major, and about classmates in their major. At Time 1, the questions were about their expectations for how they would feel about their major (given that Time 1 occurred before classes began), and at Time 2 the questions were about how they actually felt (rather than their expect-ations). Participants indicated, on a 1 to 10 scale, how much they: fit in, feel welcome, comfortable, and thrilled to be in their major (four items), and how much they like and feel comfortable with their professors (two items) and peers in their major (two items). For example, one item read "How do you feel about your major?" and participants answered on the scale ranging from 1 (I feel very uncomfortable) to 10 (I feel very comfortable). A mean of all eight items was computed to create a composite scale. At both time points, the scale demonstrated good internal reliability (Cronbach's Alphas≥.94).

Similar to the sense of belonging in major scale, participants then completed the same eight questions about their feelings of belonging at the University in general. For example, one item read "How do you feel about Stony Brook University?" and participants answered on the scale ranging from 1 (I feel very uncomfortable) to 10 (I feel very comfortable). A mean of all eight items was computed to create a composite scale. At both time points, the scale demonstrated good internal reliability (Cronbach's Alphas≥.89).

Results

Means, standard deviations, and bivariate correlations for major study variables can be found in Table 1.

Analyses of Change Over Time

First, repeated-measures ANOVAs were used to examine the pattern of change for WISE women in the variables assessed at both time points (perceived identity compatibility, social support from close others, sense of belonging in STEM, and

sense of belonging at the university), to examine the first hypothesis that these variables might decline across the first year of college. There was partial support for the first hypothesis in the analyses to follow.

At both time points, participants scored around the midpoint of the perceived identity compatibility scale ($M=$ 4.94 at Time 1, 4.88 at Time 2 on a scale of 1 to 7), and the repeated-measures ANOVA for perceived identity compati-bility did not reveal a significant change over the two time points, $F(1, 64)=.10$, $p=.759$. Participants also reported high levels of perceived social support from close others at both time points ($M=6.46$ at Time 1, 5.91 at Time 2 on a scale of 1 to 7), and the repeated-measures ANOVA did reveal a significant decrease in perceived social support from close others over time, $F(1, 64)=13.35$, $p=.001$. Participants also reported fairly high levels of perceived social support from the single-sex WISE program at Time 2 ($M=5.35$ on a scale of 1 to 7).

Participants reported moderately high levels of sense of belonging in their STEM major at both time points ($M=$ 7.35 at Time 1, 6.74 at Time 2 on a scale of 1 to 10), and the repeated-measures ANOVA revealed a significant decrease in sense of belonging in one's major over time, $F(1, 64)=7.32$, $p=.009$. Similarly, participants reported moderate levels of sense of belonging at the university at both time points ($M=7.07$ at Time 1, 6.66 at Time 2 on a scale of 1 to 10), and the repeated-measures ANOVA revealed a marginally significant decrease in sense of belonging at the university over time, $F(1, 64)=3.15$, $p=.081$.

Regression Analyses

Second, hierarchical regression analyses were used to examine the second and third hypotheses that greater perceived identity compatibility and perceived social support from both close others and the single-sex program would predict greater sense of belonging in one's STEM major, and greater sense of belonging at the university. High School GPA was controlled in all regression analyses. The outcome variables used in two separate regression analyses were sense of belonging in major and sense of belonging at Stony Brook University at the Fall follow-up survey (Time 2, 1 year after starting college), and for each of these analyses, the appropriate sense of belonging measure taken at Time 1 was also included in the model to control for the effect of students' expected sense of belonging when entering college. Thus, the regression analyses conducted examine whether perceived identity compatibility and social support from close others and the single-sex STEM program predict sense of belonging a year after starting college, over and above the effects of students' High School academic achievement or expectations when starting college. For both regression analyses, none of

Table 1 Bivariate correlations, means, and standard deviations for study variables ($N=65$)

Variable	1	2	3	4	5	6	7	8	9	10
1. High School GPA	____									
2. Compatibility between Gender and Major T1	−.08	____								
3. Support from Close Others T1	.13	.16	____							
4. Sense of Belonging in STEM Major T1	.29*	.05	−.10	____						
5. Sense of Belonging at Stony Brook University T1	.28*	.02	.04	.67**	____					
6. Compatibility between Gender and Major T2	.07	.49**	.01	.19	.14	____				
7. Support from Close Others T2	.05	−.01	.32**	.04	.10	.18	____			
8. Support from WISE Program T2	.04	−.05	.08	.24	.06	.10	.35**	____		
9. Sense of Belonging in STEM Major T2	.26*	−.04	.15	.27*	.35**	.36**	.47**	.47**	____	
10. Sense of Belonging at Stony Brook University T2	.13	.03	−.06	.18	.30**	.32**	.34**	.34**	.72**	____
M	94.72	4.94	6.46	7.35	7.07	4.88	5.91	5.35	6.74	6.66
SD	3.54	1.65	.93	1.32	1.23	1.53	1.13	1.36	1.66	1.80

High School GPA was measured on a 100-point scale; Compatibility between gender and major as well as support measures on a 1–7 scale; Sense of belonging measures on a 1–10 scale

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

the variance inflation factors exceeded 1.2, indicating that multicollinearity was not a problem in these analyses (Kleinbaum et al. 1998).

Sense of Belonging in Major

A regression analysis was conducted to examine the association between the model variables (perceived compatibility between gender and major, social support for major by close others, and social support for major by the WISE program) and sense of belonging in one's major at Time 2. As already described, we controlled for High School GPA and expected sense of belonging in one's major at Time 1 by entering them as predictors in the first step, then entered perceived compatibility between gender and major, social support for major by close others, and social support for major by the WISE program at Time 2 as simultaneous predictors in the second step. Table 2 shows the results from this regression analysis. High School GPA was only a marginally significant predictor, and expected

sense of belonging in one's major at Time 1 was not a significant predictor of sense of belonging in one's major at Time 2. However, consistent with our hypotheses, greater perceived compatibility between one's gender and STEM major, greater support for one's choice of major from close others, and greater support for one's choice of major from the WISE program at Time 2 were all significantly associated with greater sense of belonging in one's major at Time 2. The results of this analysis suggest that perceived identity compatibility, and support both from close others and from people associated with the WISE program are important predictors of sense of belonging in STEM major for female undergraduates, even when controlling for expected sense of belonging 1 year earlier and for High School GPA.

Sense of Belonging at Stony Brook University

Next, a similar regression analysis was conducted to examine the association between the model variables and

Table 2 Summary of hierarchical regression analyses for prediction of sense of belonging in STEM Major at T2 ($N=65$)

Variable	B	SE B	β
Step 1			
High School GPA	.09	.06	.19
Sense of Belonging in STEM Major T1	.27	.16	.21
Step 2			
High School GPA	.09	.05	.19
Sense of Belonging in STEM Major T1	.10	.13	.08
Compatibility between Gender and Major T2	.27	.11	.25*
Support from Close Others T2	.45	.16	.31**
Support from WISE Program T2	.37	.13	.31**

$R^2=.11$ for Step 1 ($p=.031$); $\Delta R^2=.34$ for Step 2 ($p<.001$)

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

sense of belonging at Stony Brook University at Time 2. Table 3 shows the results from this regression analysis. High School GPA was not a significant predictor, and expected sense of belonging at Stony Brook University at Time 1 was a marginally significant predictor of sense of belonging at Stony Brook University at Time 2. Again, consistent with our hypotheses, greater perceived compatibility between one's gender and STEM major, and greater support for one's choice of major from the WISE program at Time 2 were both significantly associated with greater sense of belonging at the university at Time 2. However, although greater support for one's choice of major from close others demonstrated a trend toward a positive relationship with sense of belonging at the university, this relationship was not statistically significant. The results of this analysis suggest that perceived identity compatibility, and particularly support from people associated with the WISE program are important predictors of sense of belonging at their university for female undergraduates pursuing a STEM major, even after controlling for expected sense of belonging 1 year earlier and for High School GPA.

Exploratory Analyses

Race/Ethnicity

Given the importance of examining possible racial and ethnic differences in women's experiences in STEM (e.g., Settles 2006; Settles et al. 2009) and exploring the generalizability of results, we also conducted analyses exploring whether race/ethnicity predicted sense of belonging in one's major or at one's university, or moderated any of the above significant effects. Because of a limited sample size, we could not compare all groups to one another; thus, we conducted two sets of analyses to examine whether being European

American/White or being European American/White or Asian American predicted either outcome variable or moderated any of the associations between the predictor and outcome variables in the study. None of these effects of race/ethnicity was significant.

Family Income

Additionally, given the importance of investigating potential differences in women's experiences in STEM based on their socioeconomic status (e.g., see Smithers and Robinson 2006), we explored whether students' family income predicted sense of belonging in one's major or at one's university, or moderated any of the above significant effects. None of the effects of family income were significant.

Discussion

Around the world, women continue to be outnumbered by men in STEM fields. Consensus across numerous research studies from the U.S. to Canada and England (Blickenstaff 2005) suggests that such gender disparities are due in large part to the marginalization and bias that women and girls face as students in co-educational STEM environments (Blickenstaff 2005). Single-sex schooling or single-sex programs within co-educational environments are a potentially effective solution to help promote women's engagement in STEM fields despite the sexism they face in those fields. However, to date, the mechanisms and processes through which single-sex programs may contribute to engagement in STEM fields for women are not well understood. In the present investigation, we investigated the importance of two psychological variables theorized to be centrally important to women's STEM engagement, in a racially, ethnically, and socioeconomically diverse group of women enrolled in a single-sex program for women in STEM majors at a co-educational university.

Study findings support the importance of two main theoretically-guided variables in predicting psychological engagement in STEM for undergraduate women in the U.S. Perceived compatibility between being a woman and being in a STEM field, along with perceived social support from both close others and from people affiliated with a single-sex program were found to be important elements in predicting women's engagement across their first, transitional year to college. Our findings suggest that single-sex programs might successfully focus on identity compatibility and social support to increase engagement of college women in STEM majors. Particularly, greater perceived social support from people affiliated with the WISE program predicted greater sense of belonging both in women's STEM major and at the university in general,

Table 3 Summary of hierarchical regression analyses for prediction of sense of belonging at Stony Brook University at T2 (N=65)

Variable	B	$SE\ B$	β
Step 1			
High School GPA	.03	.06	.05
Sense of Belonging at Stony Brook T1	.41	.19	.28*
Step 2			
High School GPA	.02	.06	.04
Sense of Belonging at Stony Brook T1	.33	.17	.22
Compatibility between Gender and Major T2	.27	.13	.23*
Support from Close Others T2	.31	.19	.19
Support from WISE Program T2	.31	.16	.24*

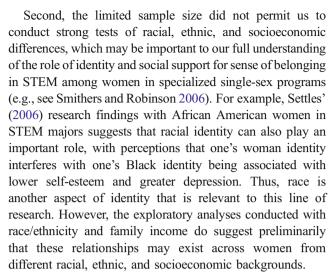R^2 =.09 for Step 1 (p=.053); $\Delta\ R^2$ =.20 for Step 2 (p=.002)

*p<.05

above and beyond the contribution of perceived social support from close others (i.e., family and friends). This underscores the likely benefit of single-sex programs for STEM women in co-educational universities, specifically in terms of providing a source of social support, an essential element for women's engagement in STEM fields.

The present investigation had several notable strengths. First, we examined a single-sex program within the context of theoretically-based variables, whereas reviewers of the literature have lamented that past work has tended to lack a cogent and clearly spelled out theoretical basis (e.g., see Protheroe 2009). Second, we collected data reflecting our key variables from participants in the program longitudinally, and specifically, across the initial transition period to college, which has been targeted by past research as being a crucial time for women interested in pursuing careers in STEM fields (e.g., Brainard and Carlin 1998; Erwin and Maurutto 1998). Third, the investigation included two cohorts of women enrolled in the single-sex program; thus, the findings are not limited to one cohort. Fourth, data analyses accounted for other variables that may have alternatively explained study findings, including academic achievement in High School and expectations before entering college.

Limitations and Future Directions

First, this study included female students in a single-sex STEM program at only one co-educational university; thus, whether the findings are generalizable to other single-sex programs at other universities, in other regions of the U.S., or in other parts of the world, is not clear. Whether the relationships studied are specific to women who are highly invested in STEM fields already (which the WISE women are assumed to be) or can be applied to less-invested women is unclear from this study as well. Nonetheless, the study was conducted at a mid-sized public university, which is representative of many other universities across the country, with a racially, ethnically, and socioeconomically diverse sample of female students. As well, because the study did not contain a comparison sample not enrolled in the single-sex program, this study does not provide evidence of whether the single-sex program environment actually results in increased engagement for undergraduate women in STEM majors, or whether perceived identity compatibility and perceived social support are particularly relevant to the single-sex program context, or more broadly for all women or all students in STEM fields. Thus, future work may want to examine these constructs and associations in women that are enrolled in a single-sex program compared with women at the same university not enrolled in a single-sex program and compared with men at the same university.

Second, the limited sample size did not permit us to conduct strong tests of racial, ethnic, and socioeconomic differences, which may be important to our full understanding of the role of identity and social support for sense of belonging in STEM among women in specialized single-sex programs (e.g., see Smithers and Robinson 2006). For example, Settles' (2006) research findings with African American women in STEM majors suggests that racial identity can also play an important role, with perceptions that one's woman identity interferes with one's Black identity being associated with lower self-esteem and greater depression. Thus, race is another aspect of identity that is relevant to this line of research. However, the exploratory analyses conducted with race/ethnicity and family income do suggest preliminarily that these relationships may exist across women from different racial, ethnic, and socioeconomic backgrounds.

Third, study findings are limited to high-performing female students in high school who were admitted to and opted to enroll in a single-sex program at a co-educational university. These women may be different from women who did not meet the standards for entry to such a program or who did not choose to apply.

Finally, although the attrition rate for study participants is comparable to prior work, findings are limited to the women who were willing to continue to participate in the study over the course of a year. Although analyses comparing women who left the study did not reveal significant differences on any study variables, women who remained in the study may have differed from women who did not in other ways.

In addition to the need for further investigation of the importance of identity compatibility and social support in STEM women, these are likely to be important contributors to engagement, achievement, and success for women in other non-traditional domains or fields in which they are underrepresented. Thus, these factors may be applicable to understanding both single-sex and co-educational programming in other fields. Additionally, it is possible that these factors are relevant to other groups that have been traditionally marginalized and underrepresented in various domains. As already mentioned, previous work (e.g., Settles 2006) suggests that identity compatibility between one's racial or ethnic background and one's college major or career is relevant to study in understanding racial/ethnic disparities in representation in various fields; additionally, various sources of social support likely play a central role in levels of engagement that members of other underrepresented groups feel in various domains.

Implications for Educators and Policy Makers

Although more research is needed to help educators and policy makers make firm conclusions about which pathway is best for women—single-sex educational programs,

single-sex classes within co-educational schools, co-educational programs, or programs not yet conceived—the findings from the present investigation can be used to suggest how such programs can be evaluated and conceptualized. By utilizing theoretical contributions from social, health, and developmental psychology, we were able to highlight the importance of two key variables involved in women's engagement in STEM fields and their university during the transition to college. Drawing on theoretical models can help pinpoint elements to include when developing, evaluating, and modifying single-sex programs or educational environments aimed at retaining women in STEM fields. For example, increasing and sustaining perceived identity compatibility might be achieved by exposing women to examples of successful women in STEM fields, as role models or examples of the compatibility between being a woman and having a STEM career (e.g., Rosenthal et al. 2009). Our findings demonstrating that social support from a single-sex program (in this case, the WISE program) predicts greater sense of belonging in STEM and at the university in general suggest that single-sex programming within co-educational environments may have their own pivotal role to play in providing social support from staff, faculty, and other peers enrolled in the program.

Conclusion

Research on single-sex programs and schooling has contributed substantially to the theoretical and practical discussion of how to increase the number of women in STEM fields and thereby expand the talent pool of those who make exciting and significant breakthroughs in science, technology, engineering, and math. This longitudinal examination of individual differences in two theoretically-derived variables allowed us to investigate the dynamic process and mechanisms through which women enrolled in single-sex STEM programs at co-educational universities sustain their engagement in STEM fields. Although it is unlikely that there is a one-size-fits-all program that will fulfill the needs of all women and sustain them in their pursuit of STEM careers, there are likely to be factors that apply to most women in STEM fields, and our findings suggest that perceived identity compatibility and perceived social support may be two such factors. Further consideration of theoretically and empirically based variables longitudinally, and specifically across important transition periods, is important for our understanding of how we may increase engagement, retention, and success of women in STEM.

References

American Association of University Women (AAUW). (2004). *Under the microscope: A decade of gender equity projects in the sciences*. Washington, DC: American Association of University Women Educational Foundation.

Ancis, J. R., & Phillips, S. D. (1996). Academic gender bias and women's behavioral agency self-efficacy. *Journal of Counseling and Development, 75*, 131–137.

Aron, A., Aron, E. N., & Smollan, D. (1992). Inclusion of other in the self scale and the structure of interpersonal closeness. *Journal of Personality and Social Psychology, 63*, 596–612.

Blickenstaff, J. C. (2005). Women and science careers: Leaky pipeline or gender filter? *Gender and Education, 17*, 369–386.

Brainard, S. G., & Carlin, L. (1998). A six-year longitudinal study of undergraduate women in engineering and science. *Journal of Engineering Education, 87*, 369–375.

Bronfenbrenner, U. (1979). *The ecology of human development*. Cambridge: Harvard University Press.

Campbell, P. B., & Wahl, E. (1998). What's sex got to do with it? Simplistic questions, complex answers. In S. Morse (Ed.), *Separated by sex: A critical look at single-sex education for girls* (pp. 63–73). Washington, DC: American Association of University Women Educational Foundation.

Ceci, S. J., Williams, W. M., & Barnett, S. M. (2009). Women's underrepresentation in science: Sociocultural and biological considerations. *Psychological Bulletin, 135*, 218–261.

Deaux, K., & Major, B. (1987). Putting gender into context: An interactive model of gender-related behavior. *Psychological Review, 94*, 369–389.

Dunkel-Schetter, C., & Bennett, T. L. (1990). Differentiating the cognitive and behavioral aspects of social support. In I. G. Sarason, B. R. Sarason, & G. R. Pierce (Eds.), *Social support: An interactional view* (pp. 267–296). New York: Wiley.

Dunkel-Schetter, C., & Lobel, M. (1990). Stress among students. *New Directions for Student Services, 49*, 17–34.

Eccles, J. S. (2005). Subjective task value and the Eccles et al. model of achievement-related choices. In A. J. Elliot & C. S. Dweck (Eds.), *Handbook of competence and motivation* (pp. 105–121). New York: The Guilford Press.

Eccles, J. S. (2007). Where are all the women? Gender differences in participation in physical science and engineering. In S. J. Ceci & W. M. Williams (Eds.), *Why aren't more women in science?* (pp. 199–210). Washington, DC: American Psychological Association.

Eccles, J. S., Midgley, C., Wigfield, A., Buchanan, C. M., Reuman, D., Flanagan, C., et al. (1993). The impact of stage-environment fit on young adolescents' experiences in schools and in families. *The American Psychologist, 48*(2), 90–101.

Erwin, L., & Maurutto, P. (1998). Beyond access: Considering gender deficits in science education. *Gender and Education, 10*, 51–69.

Exline, J. J., & Lobel, M. (1997). Views of the self and affiliation strategies: A social comparison perspective. *Basic and Applied Social Psychology, 19*, 243–259.

Ferreira, M. M. (2003). Gender issues related to graduate student attrition in two science departments. *International Journal of Science Education, 25*, 969–989.

Finn, J. D. (1989). Withdrawing from school. *Review of Educational Research, 59*, 117–142.

Gall, T. L., Evans, D., & Bellerose, S. (2000). Transition to first-year university: Patterns of change in adjustment across life domains and time. *Journal of Social and Clinical Psychology, 19*, 544–567.

Garmezy, N. (1991). Resilience and vulnerability to adverse developmental outcomes associated with poverty. *The American Behavioral Scientist, 34*, 416–430.

Goodenow, C. (1993). The psychological sense of school membership among adolescents: Scale development and educational correlates. *Psychology in the Schools, 30*, 79–90.

Hoffman, M., Richmond, J., Morrow, J., & Salomone, K. (2002). Investigating "Sense of Belonging" in first year college students. *Journal of College Student Retention, 4*, 227–256.

Hogg, M. A., & Abrams, D. (1988). *Social identifications: A social psychology of intergroup relations and group processes*. Florence: Taylor & Francis/Routledge.

Hollenshead, C., Younce, P. S., & Wenzel, S. A. (1994). Women graduate students in mathematics and physics: Reflections on success. *Journal of Women and Minorities in Science and Engineering, 1*, 63–88.

Kleinbaum, D. G., Kupper, L. L., Muller, K. E., & Nizam, A. (1998). *Applied regression analysis and multivariate methods*. Pacific Grove: Duxbury.

Lazarus, R., & Folkman, S. (1984). *Stress, appraisal, and coping*. New York: Springer Publishing Company.

Levy, S. R., West, T., & Ramirez, L. (2005). Lay theories and intergroup relations: A social developmental perspective. *European Review of Social Psychology, 16*, 189–220.

London, B., Downey, G., Bolger, N., & Velilla, E. (2005). A framework for studying social identity and coping with daily stress during the transition to college. In G. Downey, J. Eccles, & C. Chatman (Eds.), *Navigating the future: Social identity, coping, and life tasks* (pp. 45–63). New York: Russell Sage.

London, B., Downey, G., Bonica, C., & Paltin, I. (2007). Social causes and consequences of rejection sensitivity. *Journal of Research on Adolescence, 17*, 481–506.

London, B., Rosenthal, L., & Gonzalez, A. (2011). Using experience sampling methodology to capture the impact of identity, support, and gender rejection on the academic engagement of women. *Journal of Social issues, 67*(3).

Mael, F., Alonso, A., Girbson, D., Rogers, K., & Smith, M. (2005). *Single-sex versus co-educational schooling: A systematic review*. Washington, DC: U.S. Dept. of Education.

Meinholdt, C., & Murray, S. L. (1999). Why aren't there more women engineers? *Journal of Women and Minorities in Science and Engineering, 5*, 239–263.

Mendoza-Denton, R., Downey, G., Purdie, V., Davis, A., & Pietrzak, J. (2002). Sensitivity to status-based rejection: Implications for African-American students college experiences. *Journal of Personality and Social Psychology, 83*, 896–918.

National Science Foundation, Division of Science Resources Statistics, *Women, Minorities, and Persons with Disabilities in Science and Engineering: 2009*, NSF 09-305, (Arlington, VA; January 2009). Available from http://www.nsf.gov/statistics/wmpd/.

Osterman, K. F. (2000). Students' need for belonging in the school community. *Review of Educational Research, 70*, 323–367.

Ostrove, J. M., & Long, S. M. (2007). Social class and belonging: Implications for college adjustment. *The Review of Higher Education, 30*, 363–389.

Protheroe, N. (2009). Single-sex classrooms. *Principal*, May/June. Retrieved from http://www.naesp.org.

Roccas, S., & Brewer, M. B. (2002). Social identity complexity. *Personality and Social Psychology Review, 6*, 88–106.

Rosenthal, L., London, B., Levy, S. R., Lobel, M., Guarino, M., Bermeo, J., et al. (2009, August). *Role models increase women's engagement in science*. Poster presented at the annual meeting of the American Psychological Association. Toronto, Canada.

Ruble, D., & Seidman, E. (1996). Social transitions: Windows into social psychological processes. In E. T. Higgins & A. Kruglanski (Eds.), *Social psychology: Handbook of basic principles* (pp. 830–856). New York: Guilford Press.

Settles, I. H. (2004). When multiple identities interfere: The role of identity centrality. *Personality and Social Psychology Bulletin, 30*, 487–500.

Settles, I. H. (2006). Use of an intersectional framework to understand Black women's racial and gender identities. *Sex Roles, 54*, 589–601.

Settles, I. H., Jellison, W. A., & Pratt-Hyatt, J. S. (2009). Identification with multiple social groups: The moderating role of identity change over time among women scientists. *Journal of Research in Personality, 43*, 856–867.

Shih, M., Pittinsky, T. L., & Ambady, N. (1999). Stereotype susceptibility: Identity salience and shifts in quantitative performance. *Psychological Science, 10*, 81–84.

Smithers, A., & Robinson, P. (2006). *The paradox of single-sex and co-educational schooling*. Buckingham, UK: Carmichael Press.

Steele, J., James, J. B., & Barnett, R. C. (2002). Learning in a man's world: Examining the perceptions of undergraduate women in male-dominated academic areas. *Psychology of Women Quarterly, 26*, 46–50.

Tajfel, H., & Turner, J. C. (1979). An integrative theory of intergroup conflict. In W. G. Austin & S. Worchel (Eds.), *The social psychology of intergroup relations* (pp. 33–47). Monterey: Brooks/Cole.

Taylor, S. E., & Lobel, M. (1989). Social comparison activity under threat: Downward evaluation and upward contacts. *Psychological Review, 96*, 569–575.

Tropp, L. R., & Wright, S. C. (2001). Ingroup identification as the inclusion of ingroup in the self. *Personality and Social Psychology Bulletin, 27*, 585–600.

Walker, C. O., & Greene, B. A. (2009). The relations between student motivational beliefs and cognitive engagement in high school. *The Journal of Educational Research, 102*, 463–471.

Warrington, M., & Younger, M. (2000). The other side of the gender gap. *Gender and Education, 12*, 493–508.