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ORIGINAL ARTICLE

Explaining Underrepresentation: A Theory of Precluded Interest

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Abstract What processes best explain women's underrepresentation in science, math, and engineering fields in the U.S.? Do they also explain men's underrepresentation in the humanities? Two survey studies across two U.S. West Coast universities (N=62; N=614) addressed these questions in the context of two fields: one male-dominated (computer science) and the other female-dominated (English). Among a set of social predictors—including perceived similarity to the people in the field, social identity threats, and expectations of success—the best mediator of women's lower interest in computer science and men's lower interest in English was perceived similarity. Thus, changing students' social perceptions of how they relate to those in the field may help to diversify academic fields.

Keywords Underrepresentation · Gender differences · Interest · Recruitment · Similarity

Introduction

Despite considerable progress in diversifying previously homogenous domains, women continue to experience significant underrepresentation across a spectrum of academic fields in science, technology, engineering, and mathematics (STEM), both in the U.S. and in other countries (Else-Quest et al. 2010; National Science Foundation 2009; Nosek et al. 2009). Numerous scholars across a variety of disciplines have weighed in on social and biological underpinnings of the underrepresentation of women in STEM fields. In an effort to reconcile conflicting findings and identify what factors best explain this underrepresentation, Ceci et al. (2009) conducted a comprehensive review of over 400 studies. In assessing this literature, the authors identified women's preferences as the primary explanation, as "mathematics-capable women disproportionately choose non-mathematics fields" (p. 251). But *why* are these women—many of whom grew up with the internet, took math and science classes in high school, and have just as much quantitative ability as their male peers (Hyde et al. 2008)—still not choosing STEM fields? The first aim of the current work is to examine the social factors that best explain women's lower interest in one of the most male-dominated STEM fields in the U.S.: computer science. We propose that perceptions of similarity to people in a field (Niedenthal et al. 1985) play a central role in shaping an individual's interest in that field, even after controlling for other social factors, such as social identity threat (Steele and Aronson 1995; Steele et al. 2002) and expectations of success (Bandura 1997; Eccles and Wigfield 2002; Wigfield and Eccles 2000).

In addition to the observed gender difference in STEM fields, another theoretically important, yet often overlooked, observation in American universities today is that gender disparities exist in many other fields outside of STEM. In fact, we can look at college psychology classrooms and observe a striking imbalance, but in the opposite direction: Women are majoring in psychology at a rate of more than double that of men (U.S. Department of Education 2006). Other fields, like English and history, also exhibit stark underrepresentation, with women constituting the numerical majority (U.S. Department of Educa-

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tion 2006). Do men forsake fields like English in the U.S. for the same reasons that women forsake computer science? The second aim of this paper is to examine whether the processes underlying academic interest are similar for men and women. To address these two aims, we conducted survey studies at two U.S. universities that tested for the factors underlying women and men's academic interest in computer science and English.

Understanding Academic Interest

In U.S. society, college students often have a dizzying array of majors from which to choose. Several theories from the fields of economics and education underscore the importance of earnings expectations or status-based concerns in explaining why students choose certain majors (Berger 1988; Malgwi et al. 2005; Montmarquette et al. 1997). Explanations offered by psychologists typically involve students' internal characteristics, such as their personality characteristics (Harton and Lyons 2003) or their implicit theories (Zuckerman et al. 2001). In addition, increasing interest in a domain may be particularly important to convincing students to choose a field (Malgwi et al. 2005; Morgan et al. 2001). A lack of interest in a topic is related to forsaking important classes (Jacobs et al. 1998; Turner and Bowen 1998) and to underperformance in coursework (Schiefele et al. 1992).

With regards to computer science in particular, girls and women express less interest in this field than their male peers at all levels of schooling (Dryburgh 2000). Because computer science classes at most high schools and colleges are presently not mandatory (Barker and Aspray 2006) and foregoing even a single class can effectively preclude a technical major (Moses et al. 1999), increasing women's interest in these classes is particularly important to ensuring their participation in computer science. In this paper, we theorize that precluded interest is animated by certain social factors that contribute to gender disparities in computer science.

The Role of Perceived Similarity in Precluded Interest

Academic fields, like all social groups, possess particular prototypes, or idealized group members who best embody the group's perceived traits and attributes (Turner et al. 1987). The extent to which a person's own perceived traits and attributes overlaps with these academic prototypes are related to improved attitudes toward the field (Hannover and Kessels 2004; Lee 1998; Rommes et al. 2007). For instance, among a sample of German high school students, students who perceived overlap between the self and a prototype of the typical student who is good at the field had more positive attitudes toward that field than those who perceived less overlap (Hannover and Kessels 2004). In another study, interviews with adolescent females about their attitudes toward computer science revealed that feeling dissimilar to computer scientists, even on attributes that were completely separate from computer science skills or abilities (e.g., attractiveness), were related to lower interest in computer science (Rommes et al. 2007).

Because the computer science prototype is perceived as incongruent with the female gender role (Cheryan et al. 2009; Diekman et al. in press; Margolis and Fisher 2002; Schott and Selwyn 2000), we hypothesize that women will perceive less similarity between themselves and computer scientists than men will perceive. Such perceptions of STEM fields may be inaccurate (Beyer 1999a; Borg 1999), but that does not preclude their influence (Cheryan et al. 2009). People tend to approach others they feel are similar to them (Byrne 1971; Hoyle 1993; Miller et al. 1998) and avoid those they feel are dissimilar from them (Byrne et al. 1986; Rosenbaum 1986; Singh and Ho 2000; Smeaton et al. 1989). Additionally, perceptions of similarity to a group are associated with feelings of belonging to a group (Cable and Judge 1996; Rentsch and McEwen 2002) and with the decision to join a group (Chassin et al. 1981; Gerrard et al. 2002; Gibbons and Gerrard 1995; Heilman 1983; Niedenthal et al. 1985; Walton and Cohen 2007). Thus, we predict that women's perceptions of themselves as dissimilar from computer scientists relative to men will predict their lower interest in the field.

We further propose that perceptions of similarity to the people in a field will also predict men's lack of interest in English. Because the need to belong is a fundamental human need (Baumeister and Leary 1995; Fiske 2004), people highly value fitting in with others (Baumeister et al. 2005; Molden et al. 2009; Oyserman et al. 2006; Williams et al. 2000). When it comes to expressing interest in a group, men and women are known to place equal importance on perceived similarity and fit with group members (Hannover and Kessels 2004; Niedenthal et al. 1985; Walton and Cohen 2007). Even for young boys, when it comes to academic pursuits, "fitting in matters" (Oyserman et al. 2006). Thus, we hypothesize that a lack of perceived similarity to the people in the field will be an important factor corresponding to both women's lack of interest in computer science *and* men's lack of interest in English.

By suggesting that perceived similarity drives both women's and men's interests, we are not implying that women and men face the same barriers to entering academic fields. Men benefit from higher societal status than women (Acker and Van Houten 1974; Eagly and Steffen 1984; Eagly and Wood 1999), which could offer a measure of protection to men when they find themselves in

situations where they are underrepresented. Indeed, being a male in a female-dominated domain can even afford men privileges in that domain (Williams 1992). Moreover, because current male-dominated fields enjoy greater pay and status, precluding women's participation in male-dominated fields may be more problematic than precluding men's participation in female-dominated fields. Nevertheless, by performing analyses on both genders, we investigate both the generality of process and the practical implications of intervening in those processes.

Other Social Factors That May Contribute to a Lack of Interest

Our analysis of precluded interest takes into account other social factors previously established in the literature as important predictors of interest in STEM. Because we propose that perceptions of similarity will be an important independent predictor of the gender differences in educational choices, we assess the influence of perceptions of similarity *above and beyond* the influence of these other factors by accounting for their influence in our analyses.

Social Identity Threats

Recent work in social psychology has elucidated another set of factors that influence interest in a domain: social identity threats, or the presence of potential threats to one's identity (e.g., gender). These threats can take different forms. One manifestation of social identity threat is the belief that one will be discriminated against in the domain (Adams et al. 2006; Ensher et al. 2001; Gutek et al. 1996; Pinel 1999; Schmitt et al. 2002). Another manifestation is stereotype threat, or the fear of confirming a negative stereotype about one's group (e.g., women are bad at math) (Davies et al. 2002; Schmader et al. 2008; Spencer et al. 1999; Steele 1997). Even the simple fact of being underrepresented in a domain can itself serve as a social identity threat because it can activate stereotype threat concerns (Dasgupta and Asgari 2004; Inzlicht and Ben-Zeev 2000; Murphy et al. 2007; Sekaquaptewa and Thompson 2003). A third, more general, form of social identity threat is the feeling that one's identity is not valued in the domain (Purdie-Vaughns et al. 2008; Steele et al. 2002). Previous studies have revealed that women report social identity threats in STEM (Dasgupta and Asgari 2004; Logel et al. 2010; Murphy et al. 2007; Spencer et al. 1999), and these feelings can discourage women from persisting in these fields (Davies et al. 2002; Murphy et al. 2007).

Will men feel these social identity threats in English? On the one hand, men can feel threatened by engaging in domains they consider feminine (Bosson et al. 2005; Rudman and Fairchild 2004). On the other hand, because the field of English, and more generally, academia, were traditionally male-dominated, and in many places still are, any benefits granted to women by being in a female-dominated field may be outweighed by an awareness of historical male dominance. Moreover, suggestions of sexism against one's gender do not seem to have the same detrimental impact on men as they do on women (Adams et al. 2006; Schmitt et al. 2002), perhaps because the effects of these suggestions are buffered by men's higher status in society (Acker and Van Houten 1974; Eagly and Steffen 1984; Eagly and Wood 1999). Thus it is possible that social identity threats in English, if perceived, will not deter men from that field.

Expectations of Success

Expecting to be successful in a domain can be a motivational force that inspires people to engage further in that domain (Bandura 1997; Beyer et al. 2003; Eccles 1994; Eccles et al. 1999; Meece et al. 1990). In general, women expect to perform worse in STEM fields than their male peers (Betz and Hackett 1981; Beyer et al. 2003; Ehrlinger and Dunning 2003). This belief contributes to women's lower likelihood of pursuing those fields (Chipman et al. 1992; Crombie et al. 2005; Eccles 1994; Eccles et al. 1999; Ehrlinger and Dunning 2003; Hackett et al. 1992). Men also report lower expectations of success in feminine domains (e.g., languages) (Betz and Hackett 1981; but see Beyer 1999b), which may interfere with their interest in these domains. In this work, we control for these expectations of success in explaining a lack of academic interest among both men and women.

Why Computer Science and English?

We chose to focus our analysis specifically on the fields of computer science and English for both theoretical and practical purposes. From a theoretical perspective, both computer science and English are popular majors on college campuses. However, the pattern of underrepresentation differs between the two fields: In 2006, women made up 21% of computer science majors in the U.S. while males made up 31% of English majors in the U.S. (U.S. Department of Education 2006). Examining these fields allows us to compare the factors precluding women's participation to those precluding men's participation. By examining gender differences in two academic fields, we also seek to "make gender comparisons more meaningful" by contextualizing gender within multiple social contexts to elucidate the source of potential differences (Yoder and Kahn 2003, p. 1).

Practically, we hope to explain why girls at every level of school in the U.S. are less interested in pursuing computer science than boys (Dryburgh 2000; Eccles 1994). Researchers

and the public typically blame parents, teachers (Sadker and Sadker 1994), and the computing industry (Chappell 1996; Kiesler et al. 1985) for socializing boys to be more interested in computers than girls. Despite efforts to increase the participation of women in computer science, the overall percentage of women who graduate with a degree in computer science from American universities has not increased, but instead has actually decreased over the past three decades (National Science Foundation 2009), suggesting that more research is needed to understand the factors that might be precluding women's interest in computer science.

Overview of Current Work

Previous work on understanding gender differences in academic pursuits typically focuses on one social group (e.g., women), one field (e.g., math), and one explanation (e.g., social identity threat). Our studies instead compare male and female U.S. undergraduates across two fields and consider multiple mechanisms. We examine: (a) what social factors best predict the gender difference in interest in academic fields, (b) whether women's and men's underrepresentation share similar underlying processes, and (c) what factors best predict which men and which women are most interested in the fields. Because a problem as complex as underrepresentation is undoubtedly caused by more than one process, we leave open the possibility of multiple explanatory paths, while also testing for the strongest predictors.

Our hypotheses are as follows:

Hypothesis 1	Women will express less interest in pursuing computer science than men, and men will express less interest in pursuing English than women (Studies 1 & 2);
Hypothesis 2	Women will report less perceived similarity to computer science majors than men, and men will report less perceived similarity to English majors than women (Studies 1 & 2);
Hypothesis 3a & b	Perceived similarity to those in the fields will mediate gender differences in interest in both computer science (Hypothesis 3a) and English (Hypothesis 3b) (Study 1);
Hypothesis 4a & b	Perceived similarity to those in the fields will predict *which women* express interest in computer science (Hypothesis 4a) and *which men* express interest in English (Hypothesis 4b) (Study 1);
Hypothesis 5a & b	Even after controlling for social identity threats and expectations of success in the field, perceived similarity will mediate gender differences in interest in computer science (Hypothesis 5a) and English (Hypothesis 5b) (Study 2);
Hypothesis 6a & b	Even after controlling for social identity threats and expectations of success in the field, perceived similarity will predict *which men* and *which women* are interested in computer science (Hypothesis 6a) and English (Hypothesis 6b) (Study 2).

Study 1

We began our examination of academic interest by identifying the relationships between gender and interest in computer science and English. We also assessed whether perceived similarity to the people in the fields mediated gender differences in interest in computer science and English.

Method

Participants

Seventy-four students in an introductory psychology class at Stanford University participated in this study as part of a mass testing session for participant pool credit. Twelve participants who did not indicate their gender were eliminated from this study, leaving 62 participants (33 females; 30 Whites, 11 Asian Americans, 7 African Americans, 7 Hispanic/Latinos, and 7 who indicated more than one race or other). The mean age of the sample was 19.44 years (SD=1.44).

Materials and Procedure

Participants were asked to complete a questionnaire about the fields of computer science and English. Interest was measured by asking students, "How much have you considered majoring in computer science/English?" (adapted from Beyer et al. 2004; Cheryan et al. 2009; Smith et al. 2005). Perceived similarity to the people in the fields was measured by asking, "How similar are you to computer science/English majors?" (adapted from Catrambone et al. 1996; Walton and Cohen 2007). All questions were answered on a scale of 1 (*not at all*) to 7 (*very much*). Demographic information (e.g., gender) was collected on a separate page.

Results

Gender Differences on All Variables

Prior to conducting the main analyses, we conducted a multivariate analysis of variance (MANOVA) to test for

overall gender differences in interest and perceived similarity in computer science and English. There was an overall significant effect of gender, $F(4, 57)=6.86$, $p<.001$, $\eta_p^2 = .33$. Women reported less interest in computer science ($M=1.70$, $SD=1.43$) than did men ($M=2.64$, $SD=1.83$), $F(1, 60)=5.18$, $p<.05$, $\eta_p^2 = .08$. Women also reported less perceived similarity to computer science majors ($M=2.21$, $SD=1.39$) than did men ($M=3.94$, $SD=1.62$), $F(1, 60)=20.63$, $p<.001$, $\eta_p^2 = .26$. Women and men did not differ in their interest in English ($M=3.36$, $SD=1.78$ vs. $M=2.86$, $SD=1.85$), $F(1, 60)=1.18$, *ns*, but women reported greater similarity to English majors ($M=4.45$, $SD=1.44$) than did men ($M=3.62$, $SD=1.49$), $F(1, 60)=5.01$, $p<.05$, $\eta_p^2 = .08$.

Gender Differences in Precluded Interest in Computer Science and English

To investigate Hypothesis 1, that women would express less interest in computer science whereas men would express less interest in English, we conducted a 2 (gender) x 2 (field: computer science, English) mixed-model analysis of variance (ANOVA) on academic interest. There was no main effect of gender, $F(1, 60)<1$, *ns*, but there was a main effect of field, $F(1, 60)=7.47$, $p<.01$, $\eta_p^2 = .11$. Students were more interested in the English major ($M=3.13$, $SD=1.82$) than in the computer science major ($M=2.14$, $SD=1.68$). However, these main effects were qualified by the hypothesized field x gender interaction, $F(1, 60)=4.35$, $p<.05$, $\eta_p^2 = .07$. As predicted, women reported significantly less interest in computer science than men did, $F(1, 60)=5.18$, $p<.05$, $\eta_p^2 = .08$. There was no difference between men's and women's interest in English, $F(1, 60)=1.18$, *ns* (see above paragraph for means).

Gender Differences in Perceived Similarity to Computer Science and English Majors

To investigate Hypothesis 2, that women would express less perceived similarity to computer science majors while men would express less perceived similarity to English majors, we conducted a 2 (gender) x 2 (field: computer science, English) ANOVA on perceived similarity. There was no main effect of gender, $F(1, 60)=2.79$, *ns*, but there was a main effect of field, $F(1, 60)=13.19$, $p=.001$, $\eta_p^2 = .18$. Students perceived themselves as more similar to English majors ($M=4.06$, $SD=1.51$) than computer science majors ($M=3.02$, $SD=1.72$). However, these main effects were qualified by the predicted field x gender interaction, $F(1, 60)=23.60$, $p<.001$, $\eta_p^2 = .28$. As predicted, women reported that they were significantly less similar to computer science majors than men did, $F(1, 60)=20.63$, $p<.001$, $\eta_p^2 = .26$, but women reported being more similar to English majors than men did, $F(1, 60)=5.01$, $p<.05$, $\eta_p^2 = .08$ (see first results paragraph for means).

Understanding Women's Precluded Interest in Computer Science

We conducted a mediation analysis (Baron and Kenny 1986) using an SPSS macro from Preacher and Hayes (2004) to examine whether perceived similarity to computer science majors mediated the relationship between gender and interest in computer science (Hypothesis 3a; Hypothesis 3b was not tested because gender did not reach significance in predicting interest in English in this study). First, as seen above, women were less interested in computer science than were men, $b=-.94$, $SE=.41$, $p<.05$. Second, women perceived themselves to be less similar to computer science majors than men, $b=-1.73$, $SE=.38$, $p<.001$. Third, perceived similarity significantly predicted how much participants were interested computer science when controlling for gender, $b=.65$, $SE=.11$, $p<.001$. Fourth, when perceived similarity was controlled for, the relationship between gender and interest in computer science was eliminated, $b=.18$, $SE=.39$, *ns*. The Sobel test indicated that perceived similarity was a significant mediator of the relationship between gender and interest in computer science, $Z=-3.52$, $p<.001$. This suggests that women are less interested in computer science than men because they feel dissimilar from whom they perceive to be in the field.

The reverse mediation model, where interest mediates the relationship between gender and perceived similarity, is also a viable possibility. To eliminate the reverse mediation model as an explanation, we compared the hypothesized mediation model to the reverse. In both models, the mediation requirements were met for Steps 1, 2, and 3. However, in Step 4, the relationship between gender and perceived similarity continued to be significant upon entering interest as a mediator in the reverse mediation model, $b=-1.21$, $SE=.32$, $p<.001$. Thus, the hypothesized model fit the data better than the reverse mediation model.

Predicting Within-Gender Interest in Computer Science and English

Next we turned to determining whether perceived similarity accounts for why some women are more interested in computer science than other women (Hypothesis 4a). We regressed, separately for women, interest in computer science on perceived similarity to computer science majors. Perceived similarity was related to greater interest in computer science for women, $b=.60$, $SE=.15$, $p<.001$. To test the same relationship for the field of English among men (Hypothesis 4b), we regressed, separately for men, interest in English on perceived similarity to English majors. Perceived similarity was related to greater interest in English for men, $b=.55$, $SE=.21$, $p<.05$. Perceived

similarity thus predicted within-gender variability, or which women were most interested in computer science and which men were most interested in English.

Discussion

Results from Study 1 confirm the pattern seen in computer science departments in universities across the country: Women were less interested in pursuing computer science than were their male counterparts. Why was there a gender difference in interest in computer science? Women felt less similar to computer science majors than men, and this lack of perceived similarity accounted for why they were less interested in pursuing the field. The alternate model, where perceived similarity and interest were reversed, proved to be less viable than the hypothesized explanation. Perceived similarity to computer science majors also predicted why some women were more likely than others to have considered the field.

Turning to the English major, men were no less interested in this field than women in our sample, which is inconsistent with the pattern we see in U.S. universities. However, the means were in the predicted direction, so it is possible that a larger sample size is necessary to reveal differences in interest in English. Regardless of this gender difference, among men, those who felt the most similar to English majors were also the most likely to have considered the field. The importance of feeling similar to the people in the major emerged in this study as a crucial factor to consider in explaining academic interest.

Study 2

Study 1 supported our hypotheses that male and female undergraduates differ in the extent to which they are interested in computer science and that this gender difference is mediated by perceived similarity. Study 2 examined the same hypotheses with a larger sample from a different university and also investigated the role of similarity in the context of other potential explanatory factors: social identity threats and expectations of success.

Method

Participants

Six hundred seventy-five students in the psychology participant pool at the University of Washington participated in this study as part of a mass testing session for participant pool credit. Ten participants who did not indicate their gender were eliminated from this study. To focus on recruiting (as opposed to retention), we eliminated from the analyses any participants who indicated that they were computer science (N=39) or English (N=12) majors, leaving 614 participants (334 females; 269 Whites, 211 Asian/Asian Americans, 13 African Americans, 13 Latinos, 39 more than one race, 23 who indicated Other, and 46 who did not identify their race). The sample was made up of mostly freshman (394; 64%) and sophomores (141; 23%), and the mean age was 18.79 years (*SD*=1.89). The most commonly reported majors were business (107; 17%), psychology (67; 11%), biology (56; 9%), undecided (49; 8%), and biochemistry (31; 5%).

Materials and Procedure

Participants were asked the same questions as Study 1 regarding their interest in the fields of computer science and English and their perceived similarity to those in the fields. In addition, we added questions about social identity threats and expectations of success. We asked four questions to tap into the various dimensions of social identity threat (Steele et al. 2002), including the presence of discrimination against one's group (Adams et al. 2006; Schmitt et al. 2002), stereotype threat (Cohen and Garcia 2005; Steele and Aronson 1995), how much one's identity (i.e., gender) is valued in the field (Purdie-Vaughns et al. 2008), and estimates of the gender proportion in each field (Inzlicht and Ben-Zeev 2000; Murphy et al. 2007). Perception of discrimination was assessed by asking, "How sexist do you think the field of computer science/English is?" (adapted from Schmitt et al. 2002). Stereotype threat was assessed by asking, "In computer science/English, how much would you worry that people would draw conclusions about you, based on what they think about your gender?" (adapted from Cohen and Garcia 2005). Gender valuation was assessed by the question, "How much do you feel your gender is valued in the field of computer science/English" (adapted from Purdie-Vaughns et al. 2008). Finally, estimates of gender proportion in the fields were assessed by asking, "What percentage of computer science/English majors do you think are men?" (adapted from Beyer 1999a). A reliability analysis revealed that, in line with theories on social identity threat (Purdie-Vaughns et al. 2008; Steele et al. 2002), these four components of social identity threat were seen as distinct by our participants (Cronbach's α's<.20; see Tables 2 and 3 for correlations), so we did not combine them in our analyses. Expectations of success were measured by asking, "If you were a computer science/English major, what do you think your final GPA (in your major) would be?" (adapted from Wigfield and Eccles 2000). All questions, besides expectations of success (assessed on a 4.0 scale) and estimated gender proportion (0%–100%), were answered on a scale of 1 (*not at all*) to 7 (*very much*).

Results

Gender Differences on All Variables

We conducted a MANOVA to test for gender differences on all variables (see Table 1 for means and standard deviations). There was an overall significant effect of gender, $F(14, 558)=15.38$, $p<.001$, $\eta_p^2 = .28$. Compared to men, women reported less interest in computer science, $F(1, 571)=46.21$, $p<.001$, $\eta_p^2 = .08$, and perceived less similarity to computer science majors, $F(1, 571)=39.12$, $p<.001$, $\eta_p^2 = .06$. Women also reported greater social identity threats in computer science in the form of more sexism, $F(1, 571)=5.83$, $p<.05$, $\eta_p^2 = .01$, more stereotype threat, $F(1, 571)=74.04$, $p<.001$, $\eta_p^2 = .12$, and lower gender valuation, $F(1, 571)=23.03$, $p<.001$, $\eta_p^2 = .04$. Men and women did not differ in their estimates of the percentage of men in computer science, $F(1, 571)<1$, *ns*. Additionally, women reported lower expectations of success in computer science than men, $F(1, 571)=15.39$, $p<.001$, $\eta_p^2 = .03$. For the field of English, compared to men, women reported greater interest, $F(1, 571)=8.75$, $p<.01$, $\eta_p^2 = .02$, and greater perceived similarity to English majors, $F(1, 571)=13.09$, $p<.001$, $\eta_p^2 = .02$. Women also reported greater social identity threats than men in English in the form of more sexism, $F(1, 571)=5.77$, $p<.05$, $\eta_p^2 = .01$, and more stereotype threat, $F(1, 571)=8.08$, $p<.01$, $\eta_p^2 = .01$; however, men did report more devaluation based on their gender in English than women, $F(1, 571)=16.80$, $p<.001$, $\eta_p^2 = .03$. Women and men did not differ in their estimated gender proportion in English, $F(1, 571)<1$, *ns*. Women also had higher expectations of success in English than men, $F(1, 571)=5.04$, $p<.05$, $\eta_p^2 = .01$. These results suggest that men may have some, but not all, of the same concerns in English that women have in computer science.

Gender Differences in Precluded Interest in Computer Science and English

To test Hypothesis 1 (gender differences in interest in computer science and English), as in Study 1, we conducted a 2 (gender)×2 (field: computer science, English) mixed-model ANOVA on academic interest. There was no main effect of field, $F(1, 609)<1$, *ns*, but there was a main effect of gender, $F(1, 609)=7.60$, $p<.01$, $\eta_p^2 = .01$. Overall, men expressed more interest than women in both fields (men: $M=2.39$, $SD=1.21$; women: $M=2.13$, $SD=1.12$). However, as in Study 1, these main effects were qualified by the hypothesized field x gender interaction, $F(1, 609)=45.63$, $p<.001$, $\eta_p^2 = .07$. As predicted, women were less interested in computer science compared to men, $F(1, 609)=48.22$, $p<.001$, $\eta_p^2 = .07$, whereas men were less interested in English compared to women, $F(1, 609)=7.25$, $p<.01$, $\eta_p^2 = .01$ (see Table 1 and Fig. 1).

Gender Differences in Perceived Similarity to Computer Science and English Majors

A 2 (gender)×2 (field: computer science, English) mixed-model ANOVA on perceived similarity tested gender differences in perceived similarity to computer science and English majors (Hypothesis 2). This analysis revealed a main effect of field, $F(1, 611)=15.25$, $p<.001$, $\eta_p^2 = .02$. Overall, students expressed more similarity to English majors ($M=3.08$, $SD=1.59$) than to computer science majors ($M=2.69$, $SD=1.57$). There was also a marginal main effect of gender, $F(1, 611)=2.89$, $p=.09$, $\eta_p^2 = .01$; men perceived more similarity ($M=2.98$, $SD=1.21$) than did women ($M=2.82$, $SD=1.06$). However, as in Study 1, these main effects were qualified by the hypothesized field x gender interaction, $F(1, 611)=46.38$, $p<.001$, $\eta_p^2 = .07$. As predicted, women perceived less similarity to computer science majors that did men, $F(1, 611)=36.17$, $p<.001$, $\eta_p^2 = .06$, whereas men perceived less similarity to English majors than did women, $F(1, 611)=11.35$, $p=.001$, $\eta_p^2 = .02$ (see Table 1 for means and standard deviations).

Understanding Women's Precluded Interest in Computer Science

Next we assessed Hypothesis 5a, that perceived similarity mediates the gender difference in computer science even when other potential mediators are taken into account. We conducted a mediation analysis with multiple mediators

Table 1 Means and standard deviations in Study 2.

	Computer Science			English		
	Women	Men		Women	Men	
Interest	1.80 (1.37)	2.69 (1.79)	***	2.46 (1.80)	2.09 (1.55)	**
Perceived similarity	2.36 (1.40)	3.10 (1.66)	***	3.28 (1.59)	2.85 (1.57)	***
Sexism	3.38 (1.61)	3.05 (1.66)	*	2.57 (1.37)	2.31 (1.41)	*
Stereotype threat	3.43 (1.70)	2.26 (1.60)	***	2.53 (1.37)	2.18 (1.43)	**
Gender valuation	3.65 (1.60)	4.32 (1.83)	***	4.32 (1.58)	3.73 (1.68)	***
Percentage male	73.34 (10.35)	72.77 (12.00)		43.30 (12.42)	43.53 (12.32)	
Expectations of success	2.90 (.73)	3.13 (.66)	***	3.24 (.55)	3.13 (.70)	*

*$p<.05$; **$p<.01$; ***$p<.001$. Expectations of success were assessed out of 4.0 (GPA) and percentage male was on a 0–100% scale. All other questions were on a scale from 1 (*not at all*) to 7 (*very much*)

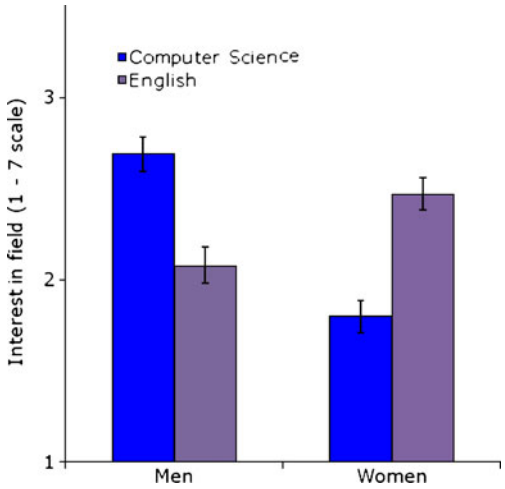

Fig. 1 Interest in computer science and English in Study 2.

(Kenny et al. 1998) using the bootstrapping macro by Preacher and Hayes (2008) with 1000 bootstrapping resamples (see Fig. 2 and Table 2 for correlations between the mediators). In Step 1, as seen above, women were less interested in computer science than were men, $b=-.91$, $SE=.13$, $p<.001$. In Step 2, relative to men, women perceived themselves as less similar to computer science majors, $b=-.80$, $SE=.13$, $p<.001$, reported more sexism, $b=.34$, $SE=.14$, $p<.05$, reported more stereotype threat, $b=1.19$, $SE=.14$, $p<.001$, reported their gender would be less valued, $b=-.68$, $SE=.14$, $p<.001$, and had lower expectations of success, $b=-.23$, $SE=.06$, $p<.001$. Women and men did not differ in the gender proportion they estimated in computer science, $b=.54$, $SE=.92$, *ns*. (Note that estimated gender proportion may not generate differences between women and men, disqualifying it as a mediator, yet it may still explain why women are less interested. We test estimated gender proportion again in a subsequent model that excludes men.) In Step 3, the only mediators that predicted greater interest in computer science upon controlling for gender and all other mediators were perceived similarity, $b=.58$, $SE=.04$, $p<.001$, stereotype threat, $b=.09$, $SE=.03$, $p<.05$, and expectations of success, $b=.41$, $SE=.08$, $p<.001$. In Step 4, the relationship between gender and interest remained significant upon entering the mediators, $b=-.47$, $SE=.12$, $p<.001$. In accordance with the analysis recommended by Preacher and Hayes (2008), perceived similarity, expectations of success, and stereotype threat were deemed significant mediators because their 95% bias-corrected confidence intervals did not include zero (perceived similarity: −.63 to −.31; stereotype threat: .01 to .21; expectations of success: −.15 to −.04). According to the pairwise contrasts generated by the macro (Preacher and Hayes 2008), perceived similarity was the strongest mediator, stronger than stereotype threat (bias-corrected 95% confidence interval: −.76 to −.39) and expectations of success (bias-corrected 95% confidence interval: −.53 to −.20). Note that because of correlations between some mediators (see Tables 2 and 3), a circumstance that is difficult to avoid in multiple mediation models (Preacher and Hayes 2008), non-significant mediators may still play a role in deterring interest.

Understanding Men's Precluded Interest in English

To test Hypothesis 5b, that perceived similarity mediates the relationship between gender and interest in English upon accounting for other potential mediators, we conducted another mediation analysis with multiple mediators (Kenny et al. 1998; Preacher and Hayes 2008) (see Fig. 2 and see Table 3 for correlations among the potential

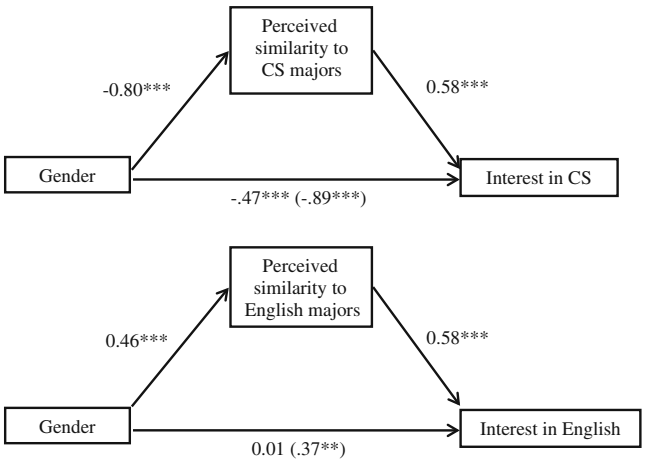

Fig. 2 Perceived similarity mediates the effect of gender on interest in computer science and English in Study 2. Analyses control for other potential mediators, including social identity threats (perceived sexism, stereotype threat, gender valuation, and estimated gender proportion) and expectations of success. Note: values are unstandardized regression coefficients. The value outside the parentheses represents the coefficient controlling for the potential mediators, and the value inside the parentheses represents the relationship without controlling for the potential mediators. **$p<.01$; ***$p<.001$.

Table 2 Correlations between potential predictors of interest in the computer science major in Study 2.

		Perceived similarity	Social identity threat				Perceived similarity	Social identity threat			
			Stereotype threat	Gender valuation	Sexism	% male		Stereotype threat	Gender valuation	Sexism	% male
		WOMEN					MEN				
Social identity threat	Stereotype threat	.11**					.04				
	Gender valuation	.20****	.01				.13**	.11*			
	Sexism	.26****	.46****	.003			.19***	.22****	.33****		
	% male	.08	.18****	-.02	.29****		.07	.11*	.16***	.21****	
Expected success		.19****	-.04	.12**	-.08	-.12*	.30****	.001	-.04	.12**	-.07

*$p<.10$;**$p<.05$; ***$p<.01$; ****$p<.001$

mediators). In Step 1, women were more interested in English than were men, $b=.41$, $SE=.14$, $p<.01$. In Step 2, relative to men, women perceived themselves as more similar to English majors, $b=.46$, $SE=.13$, $p<.001$, reported greater sexism in the field, $b=.27$, $SE=.12$, $p<.05$, reported more stereotype threat concerns, $b=.33$, $SE=.12$, $p<.01$, reported their gender would be more valued, $b=.57$, $SE=.14$, $p<.001$, and had higher expectations of success, $b=.12$, $SE=.05$, $p<.05$. Women and men did not differ in their estimates of gender proportion in the field, $b=-.56$, $SE=1.03$, *ns*. In Step 3, the mediators that predicted interest in English upon controlling for gender and all the other mediators were perceived similarity, $b=.58$, $SE=.04$, $p<.001$, stereotype threat, $b=.09$, $SE=.04$, $p<.05$, gender valuation, $b=.07$, $SE=.03$, $p<.05$, and expectations of success, $b=.41$, $SE=.09$, $p<.001$. In Step 4, the relationship between gender and interest in English was no longer significant upon entering the mediators, $b=.01$, $SE=.11$, *ns*. In accordance with the analysis recommended by Preacher and Hayes (2008), perceived similarity, stereotype threat, gender valuation, and expectations of success were deemed significant mediators because their 95% bias-corrected confidence interval did not include zero (perceived similarity: .13 to .44; stereotype threat: .001 to .08; gender valuation: .003 to .10; expectations of success: .01 to .10). According to the pairwise contrasts generated by the macro (Preacher and Hayes 2008), perceived similarity was the strongest mediator, stronger than stereotype threat (bias-corrected 95% confidence interval: .10 to .41), gender valuation (bias-corrected 95% confidence interval: .08 to .41), and expectations of success (bias-corrected 95% confidence interval: .08 to .40).

Predicting Women's Interest in Computer Science

What predicts individual differences in interest in computer science among women (Hypothesis 6a)? We included only female participants and regressed women's interest in computer science on the potential predictors mentioned above (perceived similarity, perceived sexism, stereotype threat, gender valuation, estimated gender proportion, and expectations of success). The only significant predictors were perceived similarity, $b=.45$, $SE=.05$, $p<.001$, and expectations of success, $b=.33$, $SE=.10$, $p<.001$. Stereotype threat was also marginally related to interest in computer science, $b=.08$, $SE=.04$, $p=.07$, but note that the direction of the relationship was positive. Women who were concerned with stereotype threat were *more* interested in computer science. The degree to which their gender would be valued, perceived sexism, and estimated gender proportion were not related to women's interest in computer science.

Predicting Men's Interest in English

We conducted a similar analysis to the one above to assess why some men are more interested in English than other men (Hypothesis 6b). We regressed interest in English on the same predictors as above for men in the study. Perceived similarity, $b=.54$, $SE=.05$, $p<.001$, and expectations of success, $b=.34$, $SE=.12$, $p<.01$, predicted men's interest in English, while perceived sexism, stereotype threat, gender valuation, estimated gender proportion did not.

Discussion

Gender differences in interest were revealed once again in Study 2, this time in a larger sample of students from a different university. Women were less likely to express interest in computer science than were men. However, the gender difference was reversed when it came to the field of English. Across both fields, one factor powerfully mediated these gender differences: perceived similarity to the people in the fields. The predictive power of perceived similarity endured even after accounting for other factors put forth to

Table 3 Correlations between potential predictors of interest in the english major in Study 2.

		Perceived similarity	Social identity threat				Perceived similarity	Social identity threat			
			Stereotype threat	Gender valuation	Sexism	% male		Stereotype threat	Gender valuation	Sexism	% male
		WOMEN					MEN				
Social identity threat	Stereotype threat	.17***					.12**				
	Gender valuation	.14***	.10*				.09	.05			
	Sexism	.11**	.39***	.06			.11*	.39****	-.06		
	% male	−.02	−.07	−.03	−.14***		.11*	−.15**	.01	−.24****	
Expected success		.32****	−.04	−.04	.05	.00	.39****	.04	.04	−.003	.14**

*p<.10;**p<.05; ***p<.01; ****p<.001

explain gender differences in interest, such as social identity threats and expectations of success in the field. Perceived similarity also predicted which men and which women would express interest in the two fields. Women and men who saw themselves as most similar to computer science and English majors, respectively, were the most likely to express interest in those fields, even after controlling for social identity threats and expectations of success.

The fact that estimated gender proportion was controlled for in this study suggests that feeling similar to the people in the field involves more than considering the gender of those in the field. In support of this, field research finds that increasing the number of women in a technical environment does not necessarily result in increased recruitment of women into that environment (Canes and Rosen 1995; Dynan and Rouse 1997; Martin and Marsh 2005). Believing that one is similar to the people in the field thus involves more than having one's gender represented there.

General Discussion

This work demonstrates the existence of a social factor that might powerfully explain what convinces women and men to choose certain fields. According to our findings, having a sense of similarity to the people in a field is an important predictor of interest in that field, even after controlling for other social factors, such as social identity threats and expectations of success. Perceived similarity was the strongest mediator regardless of whether the field was computer science or English, whether the participants were men or women, or whether they were at a public or private university.

Despite this similarity in underlying process between men and women, we nevertheless found gender differences in academic interest consistent with current patterns of underrepresentation on college campuses across the U.S. Compared to men, women expressed significantly less interest in majoring in computer science and perceived themselves to be less similar to computer science majors. Conversely, men expressed significantly less interest in majoring in English and perceived themselves to be less similar to English majors. Perceived similarity to the people in the fields mediated the gender disparities in both fields.

This work suggests that when considering a prospective major, a highly salient factor may be whether one would fit in as a group member or not. In order to choose computer science, women must feel similar to those in the field, or at least believe that it is worth pursuing despite feelings of dissimilarity. The current data suggest that changing women's perceptions of how they relate to people in computer science is fundamental to changing their interest in computer science. Future research on the topic of women's interest in STEM could examine perceptions of similarity in comparison to other factors that have been shown to influence women's attitudes toward STEM, such as family-related pressures (Beyer et al. 2004; Dotterer et al. 2009), implicit associations of the field with males (Nosek et al. 2002), and concerns about the lack of interpersonal fulfillment in the field (Diekman et al. in press; Morgan et al. 2001).

Interestingly, controlling for perceived similarity did not completely eliminate the gender difference in interest in computer science, which lends credence to the notion of multiple mechanisms. However, perceived similarity did fully mediate the gender difference in interest in English. Taken together, these findings support the notion that women's lower status and their years of historical underrepresentation may place additional burdens on them in choosing a STEM field that men might not face in fields where they are underrepresented.

Consistent with past research, expectations of success also mediated the gender difference in interest in STEM (Ehrlinger and Dunning 2003; Wigfield and Eccles 2000). Finding ways to raise women's expectations of success

could also help to attract them to computer science. However, also consistent with past research, expectations of success were not the only important factor in predicting STEM participation (Malgwi et al. 2005; S. E. Turner and Bowen 1998; Van de gaer et al. 2008). Indeed, previous research has suggested that expectations of success may have more of an influence on subsequent performance, while perceptions of a domain may primarily affect academic intentions and choices (Eccles et al. 1984).

Social identity threats in the form of stereotype threat also predicted who was most interested in computer science. However, note also that greater stereotype threat concerns were related to *more* interest in computer science among women. This positive relationship between stereotype threat and interest could exist because those who are most interested in a domain (i.e., highly identified with it) are more susceptible to stereotype threat concerns than those who are less interested in it (Davies et al. 2005; Lesko and Corpus 2006; Schmader et al. 2008; Spencer et al. 1999; Steele 1997). For women who are not already members of these fields, their perceptions of the people in the field may more powerfully explain what causes a lack of academic interest than how their gender is perceived by others.

How do we go about making computer science more relatable to women? One option is to change how women think about themselves, for instance, by inspiring women to see themselves as more technically-oriented. The other option is to change the image of the field to one that is more similar to how women see themselves. Previous research suggests that stereotypes of computer scientists are an effective carrier of messages about who does and does not belong in the field (Cheryan et al. 2009; Margolis and Fisher 2002; Schott and Selwyn 2000). Often times, one stereotypical image communicates to everyone what kinds of people are supposedly successful and esteemed by others in the field. In other words, current stereotypes serve as belongingness cues and help shape perceptions of similarity. Recasting the current image of computer science, perhaps through the media and relatable role models (Cheryan et al. 2010; Dasgupta and Asgari 2004; Lockwood and Kunda 1997), could change women's perceptions of how they relate to the people in the field and help to draw more women into computer science.

Conclusion

Explaining underrepresentation in academic domains requires an understanding of the processes precluding interest in them. Our research demonstrates that students face powerful identity-related constraints in particular domains. As we observed, women felt less similar to computer science majors than men, while men felt less similar to English majors than women. This lack of perceived similarity predicted less interest in entering those fields. Although we conducted our research in the U.S., this work has implications in other countries in which students experience a degree of choice in majors and similar gender imbalances exist across majors. The present findings suggest that changing students' perceptions of the people in the field constitutes an important next step to reducing gender disparities across a range of academic fields.

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