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Ambient Belonging: How Stereotypical Cues Impact Gender Participation in Computer Science

Sapna Cheryan
University of Washington

Victoria C. Plaut
University of Georgia

Paul G. Davies
University of British Columbia, Okanagan

Claude M. Steele
Stanford University

People can make decisions to join a group based solely on exposure to that group's physical environment. Four studies demonstrate that the gender difference in interest in computer science is influenced by exposure to environments associated with computer scientists. In Study 1, simply changing the objects in a computer science classroom from those considered stereotypical of computer science (e.g., Star Trek poster, video games) to objects not considered stereotypical of computer science (e.g., nature poster, phone books) was sufficient to boost female undergraduates' interest in computer science to the level of their male peers. Further investigation revealed that the stereotypical broadcast a masculine stereotype that discouraged women's sense of ambient belonging and subsequent interest in the environment (Studies 2, 3, and 4) but had no similar effect on men (Studies 3, 4). This masculine stereotype prevented women's interest from developing even in environments entirely populated by other women (Study 2). Objects can thus come to broadcast stereotypes of a group, which in turn can deter people who do not identify with these stereotypes from joining that group.

Keywords: stereotypes, belonging, cues, gender, computer science

The field of computer science is a powerful symbol of our society's modernity and technological progress, yet its failure to fully incorporate women is unacceptably anachronistic. Women now earn nearly half of the bachelor's degrees in mathematics, a percentage that has been rising over the past few decades. In contrast, computer science has over three times the number of undergraduate majors and should have the potential to recruit many more women. However, only 22% of computer science graduates are women, a percentage that has been steadily *decreasing* (National Science Foundation, 2008). Because of their underrepresentation, women are not only missing out on some of the best career opportunities (Kalwarski, Mosher, Paskin, & Rosato, 2007), but computer science is missing out on female perspectives—a fact that can have negative consequences for society, as evidenced by the negative outcomes attributed to all-male design teams (Margolis & Fisher, 2002). How can women's persistent and widespread underrepresentation in computer science be explained and addressed?

Many studies have documented how stereotypes of women (e.g., being poor at math) affect the retention of women in technical fields (Crocker, Karpinski, Quinn, & Chase, 2003; Davies, Spencer, Quinn, & Gerhardstein, 2002; Spencer, Steele, & Quinn, 1999); however, much less experimental work has focused on the barriers that prevent women from developing an interest in those fields in the first place. Rather than focusing on how a stereotype associated with the target's identity (e.g., women are bad at math) influences performance among those who are already invested in a domain (Schmader, Johns, & Forbes, 2008; Shapiro & Neuberg, 2007; Steele, 1997), we focus on how *stereotypes of a field* drive gender differences in the expression of interest by those who are not already in the field. Thus, the first goal of the present article was to demonstrate that stereotypes of a domain should be taken into account when attempting to diversify that domain.

The second goal of this article was to demonstrate that these stereotypes can be communicated (and altered) merely through the physical cues present in an associated environment (e.g., classroom). Environments can act like gatekeepers by preventing people who do not feel they fit into those environments from ever considering membership in the associated groups. Because successful entry into fields like computer science often require early course completion in technical subjects (Moses, Howe, & Niesz, 1999), making initial sites of exposure, such as classrooms and departments, signal to women that they belong there is critical to ensuring their future participation. In this article, we examined whether altering computer science environments can increase women's sense of belonging and interest in the field.

Sapna Cheryan, Department of Psychology, University of Washington; Victoria C. Plaut, Department of Psychology, University of Georgia; Paul G. Davies, Department of Psychology and Computer Science, University of British Columbia, Okanagan, Kelowna, British Columbia Canada; Claude Steele, Department of Psychology, Stanford University.

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Correspondence concerning this article should be addressed to Sapna Cheryan, Department of Psychology, University of Washington, Guthrie Hall, Box 351525, Seattle, WA 98195. E-mail: scheryan@u.washington.edu

Broadcasting Stereotypes Through Ambient Identity Cues

People infer characteristics about strangers simply from a glimpse at their possessions (Gosling, Ko, Mannarelli, & Morris, 2002). Belongings like cowboy boots and flag pins communicate to people—accurately or not—qualities of the individuals who possess them (Belk, Bahn, & Mayer, 1982; Berger & Heath, 2007; Wernerfelt, 1990). Similarly, it is possible that exposure to objects placed in group environments could communicate characteristics of group members. We term these objects *ambient identity cues*, or socially symbolic objects that embody and communicate group member stereotypes to others prospectively evaluating the group. If one's identity is incompatible with those stereotypes, then he or she can feel a compromised sense of belonging in the environment, which in turn can thwart interest in the group.

Although we focused on how objects in computer science environments can preclude women's interest in computer science, the importance of this observation extends beyond the academic domain. Walking into a school adorned with Christian symbolism may make a nonreligious student wary of enrolling. Driving through a city with bicycle stores and ski racks crowning every other car may make that city unappealing to those who do not consider themselves outdoor enthusiasts. Entering a store with loud dance music may signal to older shoppers that they would be out of place there. Note that these physical environments, though exclusionary for some, can be welcoming to others—namely, those for whom the ambient identity cues signal inclusion. Environments that are incompatible with one of the more prominent social identities (e.g., gender, race; Stangor, Lynch, Duan, & Glas, 1992) may cause a particularly powerful deterrence.

What stereotypes are associated with the domain of computer science? In our studies, we examined whether stereotypical objects like Star Trek posters and video games signal a masculinity that precludes women from ever developing an interest in computer science. This masculinity might not correspond to a traditional definition that includes, for instance, strength, assertiveness, and sexual prowess (Bem, 1974; Cejka & Eagly, 1999; Cheryan, Cameron, Katagiri, & Monin, 2009). Yet, computer science is still considered a masculine field because of its association with males (Margolis & Fisher, 2002; Schott & Selwyn, 2000).

Although an overrepresentation of men is certainly a factor in explaining why women have not pursued computer science in large numbers (Inzlicht & Ben-Zeev, 2000; Marx & Roman, 2002; McIntyre, Paulson, & Lord, 2003; Murphy, Steele, & Gross, 2007; Sekaquaptewa & Thompson, 2003), it does not explain how other historically male-dominated fields (e.g., medicine, law) have managed to attract a significantly greater proportion of women despite their initial underrepresentation (National Science Foundation, 2008). Perhaps more importantly, interventions focused on numerical representation, although important, do not suggest how to start the cycle of recruiting more women and minorities into computer science and other similar domains, given that they are currently underrepresented there.

We argue that the stereotypicality of a group, defined as the degree to which group members are perceived as embodying the group's stereotypes, has a profound influence on the ability to effectively recruit people who do not see themselves as fitting those stereotypes. Computer scientists—whether they are men or women—who embody the stereotypes of their field (e.g., liking science fiction, obsessed with computers) may be less effective at recruiting women to computer science than other men and women who defy these stereotypes. The theoretical significance of this observation can be broadly extrapolated not only to other academic fields (e.g., math) but also to other social groups that are interested in diversifying their membership (see Plaut, Thomas, & Goren, 2009).

Masculine Stereotypes and Ambient Belonging

Why might a masculine computer science environment interfere with women's interest in computer science? Masculinity may portray the environment in a way that is incompatible with women's sense of themselves as female (Nosek, Banaji, & Greenwald, 2002) and prevent them from feeling like they fit well there. We term this feeling of fitting into an environment *ambient belonging*. Ambient belonging includes fit with the material (e.g., physical objects) and structural (e.g., layout) components of an environment along with a sense of fit with the people who are imagined to occupy that environment. Ambient belonging, we argue, can be ascertained rapidly, even from a cursory glance at a few objects.

People can be deterred from domains when they do not feel a sense of belonging with the people in them (Astin, 1993; Chassin, Presson, Sherman, Corty, & Olshavsky, 1981; Gerrard et al., 2002; Gibbons & Gerrard, 1995; Hannover & Kessels, 2004; Niedenthal, Cantor, & Kihlstrom, 1985; Oyserman, Brickman, Bybee, & Celious, 2006; Walton & Cohen, 2007). For instance, Walton and Cohen (2007) found that Black and Latino students who perceived that they had friends who fit well in computer science reported a greater sense of their own potential for success in computer science compared with those who struggled to list such friends. Notably, however, manipulating number of friends did not affect women's sense of fit or potential in computer science.

Our work manipulates the stereotypes associated with the field and examines whether altering these stereotypes can influence subsequent interest in computer science. Because the importance of belonging is ubiquitous (Baumeister & Leary, 1995; Fiske, 2004), we suggest that even those who are members of well-represented social groups are susceptible to feeling a lack of belonging in an environment that is not compatible with how they see themselves. Portraying the group in a way that is at odds with how people see themselves may prompt them to forgo attempts to join the group (Brewer & Weber, 1994; Brown, Novick, Lord, & Richards, 1992; Ledgerwood & Chaiken, 2007; Mussweiler, 2003). In contrast, offering people a different image of a group may encourage them to embrace that image (Gardner, Gabriel, & Hochschild, 2002) and assimilate to the group by considering a future there.

Our work differs in several ways from previous work that showed that certain situations can devalue or create unsafe contexts for stigmatized group members and thereby lead to disinterest (Davies et al., 2002; Murphy et al., 2007; Purdie-Vaughns, Steele, Davies, Ditlmann, & Crosby, 2008). First, these previous studies portrayed targets (e.g., women) as either underrepresented in that domain (Murphy et al., 2007; Purdie-Vaughns et al., 2008) or in a stereotypical manner (Davies et al., 2002). In contrast, our studies manipulate stereotypes of the domain (i.e., computer science) while controlling for target group representation (i.e., proportion of women) in that domain. Second, whereas these previous studies

only tested participants who were already highly identified with the domain of interest, a crucial element in evoking feelings of threat (Schmader et al., 2008; but see Shapiro & Neuberg, 2007), in our studies we examined a general undergraduate population, excluding any computer science majors who would be highly identified with the domain. Third, we examined in our study the role of the material objects in environments in communicating characteristics of the group and precluding interest. Thus, we suggest there is another type of identity threat to consider besides the fear of being negatively stereotyped (Davies et al., 2002; Schmader et al., 2008; Shapiro & Neuberg, 2007; Steele & Aronson, 1995) or of being devalued in a domain because of one's identity (Davies, Spencer, & Steele, 2005; Murphy et al., 2007; Purdie-Vaughns et al., 2008), and that is the threat resulting from entering an environment and feeling like one simply does not and would not belong there. Ambient identity cues alone may communicate such messages, and feeling a lack of ambient belonging may preclude women from ever developing an interest in domains associated with those environments.

Hypotheses

This work seeks to establish whether stereotypes of a field communicated by the environment influence who aspires to join that field, and if so, why. Below, we enumerate our specific hypotheses:

> *Hypothesis 1:* Environments can determine who enters a group.

Women's interest in computer science will depend on the portrayal of computer science environments. Stereotypical computer science environments will discourage women's interest in computer science more than nonstereotypical computer science environments (Studies 1–4). In contrast, stereotypical environments will not deter men's interest in computer science to the same extent (Studies 1, 3, and 4).

> *Hypothesis 2:* People infer stereotypes of a group upon exposure to that group's environment.

The stereotypical environment will project a masculine stereotype (Studies 2, 3, and 4). This will be true even when all the people who occupy that environment are women (Study 2).

> *Hypothesis 3a:* The inference of group stereotypes incompatible with one's identity leads to avoidance of that group, and, *Hypothesis 3b*, this process is mediated by feelings of ambient belonging.

Women who perceive the stereotypical environment as particularly masculine will express less interest in joining the group, which will be explained by their decreased sense of ambient belonging (Studies 2, 3, and 4). In contrast, perceived masculinity will not interfere with men's interest in the group (Studies 3 and 4).

> *Hypothesis 4:* A lack of ambient belonging predicts lack of interest in a domain and explains why some populations express less interest in a domain than do others.

Feeling a sense of ambient belonging will be related to greater interest in the stereotypical environment among both men and women. Women's lower sense of ambient belonging in that environment will explain the gender difference in interest in the stereotypical environment (Studies 3 and 4).

Overview of the Present Research

In the studies below, we tested the efficacy of transforming group environments to encourage diversity of membership. In each of our studies, we set up two computer science environments—one with stereotypical objects and the other without—and tested the effects of exposure to these environments on perceptions of the group and desire to participate in computer science. We also controlled for gender representation in the environments to examine the effects of ambient identity cues beyond the gender representation they evoke.

After testing the power of environments to preclude participation, we turned to examining why these environments have such an effect. First, we tested our hypothesis that environments stereotypically associated with computer science evoke a masculinity that decreases women's sense of ambient belonging and subsequently drives them away from the domain. Then, we examined whether differential feelings of ambient belonging can explain the gender difference in interest.

Study 1: Can Environments Influence Women's Interest in Computer Science?

In this study, we tested the first hypothesis, that environments alone can produce a gender difference in interest, by setting up a classroom in the computer science department in one of two ways. For the stereotypical condition, we collected objects that were considered (based on pretesting) highly stereotypical of computer science majors and placed them in the room. For the nonstereotypical condition, the stereotypical objects were removed and replaced with objects not stereotypically associated with computer science majors. Our hypothesis was that simply the presence of these stereotypical objects—with no additional information about the people in the environments—would be enough for participants to draw conclusions about whether they should consider a major in computer science. More specifically, we predicted that the stereotypical environment would deter women from computer science more than men, whereas this gender difference would be reduced in the nonstereotypical environment.

Method

Participants. Fifty-two students who were not computer science majors participated in this study. Three participants were omitted due to missing gender information, 7 students were omitted based on their year in school (4 seniors because their majors were declared and not likely to change and 3 who did not indicate year), and 3 participants were omitted because they believed the room was occupied by someone who was not in computer science or engineering (e.g., "biologist/geologist"), leaving 39 participants (22 women).

Pretest: Generating objects. Forty-four students, 33 (22 women) at the University of Georgia in introduction to psychology

and 11 female computer science majors attending a women in computer science meeting at Stanford, were asked to list objects that one might find in "the office of a stereotypical computer scientist" and "in the dorm room of a computer science major" (University of Georgia participants) or in "the office of a stereotypical computer science geek" (Stanford participants). Twenty-eight objects were mentioned by 3 or more participants. Of those, the objects that were easily procured were chosen as the objects for the stereotypical condition (a Star Trek poster, comics, video game boxes, soda cans, junk food, electronics, computer parts, software, and technical books and magazines). Objects that were similar but not stereotypical of computer scientists were chosen for the nonstereotypical objects (a nature poster, art, water bottles, healthy snacks, coffee mugs, general interest books and magazines). A separate group of 20 students (9 women) at the University of Washington rated these items on how much they associated them with computer science majors, on a scale from 1 (*not at all*) to 7 (*very much*). A 2 (environment: stereotypical, nonstereotypical) × 2 (gender) analysis of variance (ANOVA) on a composite of the stereotypical and nonstereotypical objects revealed that the stereotypical objects were indeed rated as more associated with computer science majors ($M = 5.43$, $SD = 0.81$) than the nonstereotypical objects ($M = 3.15$, $SD = 0.92$), $F(1, 18) = 66.84$, $p < .001$, $\eta_p^2 = .79$. There was no significant interaction of gender and environment, $F(1, 18) < 1$, *ns*, suggesting that men and women did not differ in the extent to which they associated the objects with computer science majors.

Materials and procedure. To associate the objects with computer scientists, the study was run in Stanford University's Gates Building, which hosts the computer science department and computer science classes and laboratories. Participants were run individually. Prior to the participant's arrival, a small classroom was set up with either the stereotypical or the nonstereotypical objects (see the *Pretest: Generating objects* section for objects).[1] Present in the room for both conditions were a table, several chairs, an overhead projector, a white board, and a side table with the following items: 10 computer programming books/manuals and six software boxes/CD cases and loose papers. To spare the objects from overuse (e.g., posters getting damaged during set up and take down), conditions were randomly alternated by day. The study was run over 4 months, with between one and seven sessions per day. Most of the sessions were held on weekends to avoid disruptions from others in the building.

Participants were told they were participating in a study in partnership with the Career Development Center regarding interest in technical jobs and internships. When they entered the room, they were told "pay no attention to the stuff in the room" because it was being shared with another group (to reduce suspicion). They were then left in the room for about 1 min (while the experimenter retrieved the materials), allowing them a chance to take in their surroundings.[2]

Participants then filled out a questionnaire on their current feelings toward computer science. All attitudinal questions were answered on a scale ranging from 1 (*not at all* or *strongly disagree*) to 7 (*very much* or *strongly agree*), except where specified. These questions included level of interest in computer science (i.e., percentage of likelihood that they were going to major in computer science from 0% to 100%, how much they had considered majoring in computer science, and how interested they were in learning computer programming, standardized and averaged together; $\alpha = .83$), how similar they were to computer science majors, their identification with computer science (i.e., importance of being good at computers, importance of being good at programming, identification with being a "geek"; $\alpha = .73$), and their confidence in their computer science abilities. The questionnaire also asked them to report their mood (e.g., happy, nervous) and how much they wondered what the experimenter would think of them. Upon completing the questionnaire, participants were brought to the lobby to fill out a final questionnaire gauging their memory for the objects in the room and soliciting their impressions of the room, such as how stereotypically representative of computer science (asked as "how geeky") they found the room and what objects they remembered from the room. Before leaving, participants were probed for suspicion regarding the objects in the room. None of the participants suspected that the objects had been part of the study.

Results

Influence of environments on interest in computer science. Can environments stereotypically associated with computer science deter women's participation (Hypothesis 1)? In a 2 (gender) × 2 (environment: stereotypical, nonstereotypical) ANOVA on interest in computer science, we found no main effects of gender, $F(1, 35) < 1$, *ns*, or environment, $F(1, 35) = 2.56$, *ns*. However, there was a significant interaction of gender and environment, $F(1, 35) = 6.91$, $p < .05$, $\eta_p^2 = .17$ (see Figure 1). As predicted, in the stereotypical environment, women were less interested in computer science than were men (women: $M = -0.55$, $SD = 0.38$; men: $M = 0.22$, $SD = 0.85$), $F(1, 35) = 4.58$, $p < .05$, $\eta_p^2 = .12$. However, in the nonstereotypical environment, there was no gender difference in interest in computer science (women: $M = 0.52$, $SD = 1.03$; men: $M = -0.04$, $SD = 0.81$), $F(1, 35) = 2.50$, *ns*.

Influence of the environments on other variables. Analyzing identification with computer science in a 2 (gender) × 2 (environment: stereotypical, nonstereotypical) ANOVA revealed no significant main effects but did reveal an interaction that approached significance, $F(1, 35) = 3.84$, $p = .06$, $\eta_p^2 = .10$. The stereotypical environment marginally reduced women's identification with computer science ($M = 4.17$, $SD = 1.43$) compared with the nonstereotypical environment ($M = 3.22$, $SD = 1.04$), $F(1, 35) = 3.18$, $p = .08$, $\eta_p^2 = .08$, whereas there was no effect of the environments on men's identification with computer science ($M = 3.63$, $SD = 1.21$ vs. $M = 3.22$, $SD = 1.04$), $F(1, 35) = 1.08$, *ns*.

[1] Photos of the room are available from Sapna Cheryan upon request.

[2] Participants then completed a 6-min word-stem completion task (Steele & Aronson, 1995) with 90 word fragments designed to measure activation of the female stereotype, the computer science stereotype, and feelings of belonging. No significant main effects or interactions in the number of words generated in any category were found. Afterwards, participants took an 18-question computer science test to assess for stereotype threat and filled out a questionnaire about their perceptions of the test. Conducting 2 (gender) × 2 (environment: stereotypical, nonstereotypical) ANOVAs revealed no significant effects on test performance, assessed as number correct over number attempted ($M = 0.59$, $SD = 0.16$), number attempted ($M = 10.95$, $SD = 2.18$), or any perceptions of the test. Controlling for performance did not alter any of the results in this study.

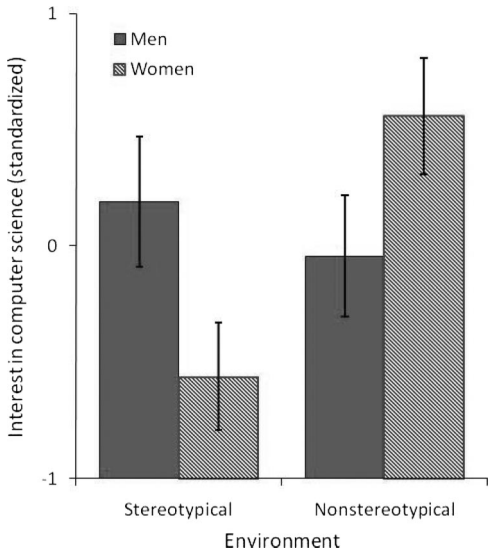

Figure 1. Reported interest in computer science by women ($N = 22$) and men ($N = 17$) in Study 1 when sitting in a room with objects stereotypically associated with computer science or not stereotypically associated with computer science.

A 2 (gender) × 2 (environment: stereotypical, nonstereotypical) ANOVA on perceived similarity to computer science majors also revealed no main effects but an interaction that approached significance, $F(1, 35) = 2.94$, $p = .095$, $\eta_p^2 = .08$. Women felt marginally less similar to computer science majors in the stereotypical environment ($M = 2.58$, $SD = 1.08$) than in the nonstereotypical environment ($M = 3.60$, $SD = 1.35$), $F(1, 35) = 3.08$, $p = .09$, $\eta_p^2 = .08$, whereas men felt equally similar to computer science majors in the stereotypical ($M = 3.38$, $SD = 1.60$) and nonstereotypical environments ($M = 2.89$, $SD = 1.45$), $F(1, 35) < 1$, *ns*.

Women reported wondering more what the experimenter would think of them ($M = 4.18$, $SD = 1.53$) than did men ($M = 2.94$, $SD = 1.75$), $F(1, 35) = 5.34$, $p < .05$, $\eta_p^2 = .13$; this was the same for both conditions and could be due to the fact that the experimenters were also women (Lockwood & Kunda, 1997; Miller, Turnbull, & McFarland, 1988). Those in the stereotypical environment remembered more objects from the room ($M = 7.95$, $SD = 3.07$) than did those in the nonstereotypical environment ($M = 6.42$, $SD = 1.58$), $F(1, 35) = 4.79$, $p < .05$, $\eta_p^2 = .12$, but this did not differ by gender, $F(1, 35) < 1$, *ns*.

A manipulation check revealed that the stereotypical environment was rated as more stereotypical (i.e., "geeky") ($M = 4.80$, $SD = 1.58$) than the nonstereotypical environment ($M = 3.95$, $SD = 1.22$), $F(1, 35) = 5.45$, $p < .05$, $\eta_p^2 = .14$, but there was also a significant Gender × Environment interaction, $F(1, 35) = 6.00$, $p < .05$, $\eta_p^2 = .15$. Men rated the room with the stereotypical objects as more "geeky" ($M = 5.63$, $SD = 1.06$) than the room with the nonstereotypical objects ($M = 3.56$, $SD = 1.01$), $F(1, 35) = 10.17$, $p < .01$, $\eta_p^2 = .23$, but women did not report a difference between the room with the stereotypical objects ($M = 4.25$, $SD = 1.66$) and the room with the nonstereotypical objects ($M = 4.30$, $SD = 1.34$), $F(1, 35) < 1$, *ns*. Although we did not predict this gender difference, especially given the lack of this effect on the same objects in the pretest, one possibility was that the use of our term *geeky* was interpreted differently by women and men because of its multiple connotations (e.g., art geek, nature geek; Roget's New Millennium™ Thesaurus, 2008). For this reason, in the subsequent studies, we avoided the term *geeky* and used *associated with computer science majors* and *associated with computer science environments*. Participants did not differ by gender or condition on reported computer science ability or mood.

Compared with baseline. We did not include a "no objects" condition in this study. So to investigate this question of baseline further, we compared the data in this study with another sample of 62 participants (33 women) from the same population who were asked how much they had considered majoring in computer science, on a scale ranging from 1 (*not at all*) to 7 (*very much*), during a questionnaire completion session. Note that these data were collected several months after the main study, so the results should be interpreted with care. A 2 (gender) × 3 (environment: baseline, stereotypical, nonstereotypical) ANOVA revealed a significant interaction, $F(2, 95) = 4.07$, $p < .05$, $\eta_p^2 = .08$. Men's desire to major in computer science was the same across the three environments, $F(2, 95) < 1$, *ns*, but women's desire to major in computer science varied, $F(2, 95) = 5.66$, $p < .01$, $\eta_p^2 = .11$. Simple effects tests revealed that women's interest was no different at baseline ($M = 1.70$, $SD = 1.43$) and in the stereotypical environment ($M = 1.17$, $SD = 0.39$), $F(1, 78) = 1.02$, *ns*, but it was higher in the nonstereotypical environment ($M = 3.40$, $SD = 1.96$), $F(1, 77) = 7.69$, $p < .05$, $\eta_p^2 = .09$. The stereotypical environment may therefore be similar to how present computer science environments are perceived, which is consistent with how we designed it. We return to the question of which environment is driving the effect in Study 4.

Discussion

How often do we think about what photos and posters we put up in our hallways and offices and what messages these cues may communicate to the undergraduates who are exposed to them? In this study, women exposed to stereotypical objects in a computer science setting expressed less interest in computer science than those exposed to nonstereotypical objects in the same room. Men exposed to the same two environments did not experience a similar reduction in their interest in computer science. This study suggests that a student's choice of classes or a major can be shaped by simply the appearance of classrooms, hallways, and offices—therefore, providing compelling evidence for the power of environments in signaling who belongs.

Why does the presence of a few objects impact women's interest in computer science? One possibility is that the presence of the stereotypical objects reminded women that this was a male-dominated field, which dissuaded them from expressing an interest in it (Dasgupta & Asgari, 2004; Murphy et al., 2007). Although this may be the case, we contend that environments do more than communicate gender proportion. They also communicate a sense of ambient belonging, defined as a feeling of fit in the environment and similarity to the people imagined to occupy it. The present study offered some initial evidence: Women in the stereotypical room felt less similar to computer science majors than did those in the nonstereotypical room. In Study 2, we further tested the role of ambient belonging by examining how women react to an environ-

ment that has stereotypical cues—yet is populated entirely by women.

Study 2: An All-Female Environment

Study 2 provided women a choice of joining one of two all-female work teams. In addition to controlling gender proportion, the teams were stated as identical in terms of the salaries participants would receive, as salary is an important determinant of college students' choices of majors (Montmarquette, Cannings, & Mahseredjian, 1997) and the work that they would do. The only difference between the teams was the objects present in their environments. Our prediction was that women would forsake employment opportunities with the team with the stereotypical room because the masculinity broadcast by those objects would make them feel that they do not belong there, even when all the other employees are women. Moreover, we predicted that the women who perceived the stereotypical environment as particularly masculine would be most susceptible to forsaking it. We also implemented two additional changes to this study. First, we used a more controlled method to generate the objects selected for both conditions. Second, we took a closer look at ambient belonging as a potential explanation of the effect.

Method

Participants. Undergraduate women ($N = 34$) from the psychology participant pool at the University of Georgia participated in this study for subject pool credit.

Pretest: Determining objects. A group of 42 undergraduate students (22 women) at the University of Washington who were not computer science majors rated the 28 objects generated by participants in the pretest to Study 1 plus six additional objects (art, nature pictures, water bottles, general magazines, healthy snacks, plants) for the degree to which they associated each object with computer science environments and with office environments, both on a scale ranging from 1 (*not at all*) to 7 (*extremely*).

Objects were chosen if they were (a) rated significantly higher (*stereotypical*) or lower (*nonstereotypical*) on association with computer science environments than office environments and (b) rated significantly above the midpoint (*stereotypical*) or below the midpoint (*nonstereotypical*) on association with computer science environments. Using these criteria generated 10 nonstereotypical objects and eight stereotypical objects. To even out the number of objects in each condition, the 2 nonstereotypical objects with the least difference in the first criterion were dropped. This left eight stereotypical objects (Star Wars and Star Trek items, electronics, software, tech magazines, computer parts, video games, computer books, and science fiction books) and eight nonstereotypical objects (water bottles, pens, coffee maker, art pictures, nature pictures, lamps, general magazines, and plants). The stereotypical objects were rated as significantly more stereotypical ($M = 6.07$, $SD = 0.71$) than the nonstereotypical objects ($M = 2.58$, $SD = 0.91$), $t(41) = 23.25$, $p < .001$, $d = 4.28$. A 2 (objects: stereotypical, nonstereotypical) $\times$ 2 (gender) ANOVA revealed that men and women did not differ in the extent to which they stereotypically associated these objects with computer science, $F(1, 40) < 1$, *ns*.

Materials and procedure. Each participant was administered a questionnaire. They were asked to imagine that they graduated and were working full time at a company; their boss wanted them to choose one of two teams to join at the company, both of which were *all-female* teams. The teams were stated as identical in terms of salary, task requirements, and hours required. Participants were told that they visited the two teams in their team rooms to learn more. One team room was described as having stereotypical objects, whereas the other team room was described as having nonstereotypical objects (see above for list of objects). Participants were tested on the gender representation of both teams after learning about the objects. Three participants did not correctly identify that the teams were all female. Removing them from the analyses did not alter results.

Participants indicated interest in the teams by specifying which team they would choose (forced choice) and then rating how much they would want to join each team, each time on a scale ranging from 1 (*not at all*) to 7 (*extremely*). Participants also rated how masculine or feminine they found the teams, on a scale ranging from 1 (*very masculine*) to 7 (*very feminine*) (reversed scored for ease of interpretation such that higher scores correspond to greater perceived masculinity). Ambient belonging was rated by two questions, how much they felt they belonged in the environment and how similar they felt to the people in the environment, both on a scale ranging from 1 (*not at all*) to 7 (*extremely*) (stereotypical environment $\alpha = .88$; nonstereotypical environment $\alpha = .93$). Questions to assess other potential mediators were included: five questions measuring stereotype threat—two adapted from G. Cohen and Garcia (2005)[3] and the remaining three adapted from Marx, Stapel, and Muller (2005; e.g., "If you worked at this company, how much would you worry that people would draw conclusions about your gender based on your performance"; stereotypical environment $\alpha = .90$; nonstereotypical environment $\alpha = .83$), one question measuring how much their gender was valued by that team, and one question measuring negativity of the environment. Stereotype threat and perceived gender valuation were gauged on a scale ranging from 1 (*not at all*) to 7 (*extremely*). Negativity was gauged on a scale ranging from 1 (*very negative*) to 7 (*very positive*) (reversed scored for ease of interpretation such that higher numbers correspond to greater negativity). Controlling for these other mediators did not alter the results presented below, as described in the *Considering alternative mediators* section.

Results

Influence of environments on job choice. In line with our hypothesis that women will avoid environments stereotypically associated with computer science (Hypothesis 1), women were much more likely to choose the team with the nonstereotypical environment (27/33; 81.8%) over the team with the stereotypical environment (6/33; 18.2%), $\chi^2(1, N = 34) = 13.36$, $p < .001$. The continuous measure similarly revealed that women were more likely to join the team with the nonstereotypical environment ($M =$

[3] These questions included one termed "stereotype threat" and another termed "the threat of being stereotyped." Because "the threat of being stereotyped" was highly correlated with the authors' "stereotype threat" question in this study, $r(34) = .87$, $p < .001$, and the subsequent two studies (both rs $> .82$, ps $< .001$), we kept both questions in our analysis. Redoing all the analyses without the "threat of being stereotyped" question yielded identical results.

4.94, $SD = 1.63$) over the team with the stereotypical environment ($M = 3.00$, $SD = 1.52$), $t(33) = -4.35$, $p < .001$, $d = 1.23$.

Reactions to the stereotypical environment. Next, we examined whether stereotypical environments evoke a masculine stereotype (Hypothesis 2). Even though both teams were entirely female, participants rated the team with the stereotypical environment as significantly above the midpoint on masculinity ($M = 5.15$, $SD = 1.33$), $t(33) = 5.03$, $p < .001$, and as significantly more masculine than the team with the nonstereotypical environment ($M = 2.59$, $SD = 1.08$), $t(33) = 8.16$, $p < .001$, $d = 2.11$.

Perceived masculinity as a mediator. Does an incompatibility between one's identity and the environment deter participation (Hypothesis 3a)? The more that women perceived the team with the stereotypical environment as masculine, the less interest they expressed in joining that team, $r(34) = -.35$, $p < .05$. We conducted a mediation analysis (Baron & Kenny, 1986) to examine whether the relationship between perceived masculinity and interest in the team with the stereotypical environment among women was mediated by a lack of ambient belonging (Hypothesis 3b). In this mediation analysis and all subsequent mediation analyses in this article, we used SPSS macros developed by Preacher and Hayes (2004) and the four steps specified by Baron and Kenny (1986) to generate and test the regression equations. In Step 1, as seen above, the more women perceived the team with the stereotypical room as masculine, the less interested they were in joining that team ($b = -.39$, $SE = .19$, $p < .05$). In Step 2, the more women perceived the team with the stereotypical room as masculine, the less ambient belonging they felt ($b = -.36$, $SE = .18$, $p = .05$). In Step 3, sense of ambient belonging predicted more interest upon controlling for masculinity ($b = .75$, $SE = .13$, $p < .001$). In Step 4, using the same equation as Step 3, perceived masculinity was no longer related to interest ($b = -.12$, $SE = .14$, *ns*). A Sobel test revealed that the drop in significance approached significance ($Z = -1.86$, $p = .06$). This was consistent with Hypothesis 3b, stating that women's relationship between perceived masculinity and interest in the team with the stereotypical environment is mediated by their feelings of ambient belonging in the stereotypical environment.

We then tested the reverse mediation model, in which the mediator and dependent variable are switched. In Step 3, entering both masculinity (independent variable) and interest (mediator) into a regression equation to predict ambient belonging (dependent variable) generated a significant effect of interest ($b = .68$, $SE = .12$, $p < .001$). In Step 4, the same regression equation revealed that upon controlling for interest, the relationship between masculinity and ambient belonging was no longer significant ($b = -.09$, $SE = .14$, *ns*). A Sobel test revealed that interest was a mediator that approached significance ($Z = -1.93$, $p = .05$). Because the results look similar for both the forward and reverse mediation models in this study, we tested both of these models again in the subsequent studies with more participants.

Discussion

This study demonstrated the novel finding that women can be deterred from a field even if their gender is well represented. Once again, women's interest in joining a group was affected by the objects in an environment. More specifically, women were driven away from a job opportunity (even one in which men were entirely absent) because the stereotypical nature of the environment communicated to them that they would not belong there. The stereotypical environment broadcast a masculine stereotype that was projected onto the team members who used that room; the more that women perceived this masculinity, the less interest they had in that team. This finding may help to explain why changing gender representation, for instance, by increasing the number of female faculty in a department, has had no effect on the number of women majoring in that field (tested in many science and engineering departments across three universities; Canes & Rosen, 1995) or on women's motivation in the classroom (Martin & Marsh, 2005). When looking for a spokesperson to attract underrepresented populations, considering more than simply that person's social category may be important (Cohoon & Aspray, 2006; Davies et al., 2002; Marx & Roman, 2002). Just as an all-female environment can make women feel like they do not belong, an all-male environment may be able to take concrete steps beyond changing their gender representation (e.g., construct their environment in a nonstereotypical manner) to signal to women that they belong there.

By asking about a team, this study extended our results beyond the computer science major, suggesting that joining many types of groups may be influenced by the stereotypes present in their environments. These results also made a case for the role of ambient belonging in the process—it mediated the relationship between masculinity and interest in the stereotypical environment. Entering an environment with objects stereotypically associated with computer science signaled to women that they did not belong there. In contrast, the same environment with objects not stereotypically associated with computer science did not broadcast a masculinity that turned women away. In the next study, we investigated this question further by adding a larger sample of women and assessing fit with the specific objects in the environment. More important, we also tried to ascertain why the stereotypical environments do not appear to affect men in the same way as women (as evidenced by Study 1).

Study 3: Why Do Stereotypical Environments Influence Interest?

The purpose of Study 3 was to examine whether objects in the environment could cause and perpetuate gender differences in interest, and if so, why. We changed the gender representation in this study to half women, thereby broadening our examination from environments that are male dominated (Study 1) and female dominated (Study 2) to those that are gender balanced, while continuing to control for gender representation across the stereotypical and nonstereotypical environments. To assess the power that these objects have in communicating stereotypes and belongingness, we asked participants to rate the masculinity of each object in the environments and how much they associated each object with themselves and with computer science majors. Finally, we also ensured that all participants accurately identified the gender representation before providing their answers.

Method

Participants. Eighty-nine students from the psychology participant pool at the University of Washington participated in this

study for partial course credit. Four computer science majors were eliminated, resulting in 85 participants (62 women).

Materials and procedure. Students arrived in groups of 1–5 and completed the study on individual computers. They were asked to imagine that they were looking for a job postgraduation (type of job was not specified) and were deciding between two companies. The jobs were stated as identical in terms of what they would be doing, salary. and hours they would work. To control gender proportion across the two companies, participants were told that "women make up HALF of the employees at the company" and were shown an accompanying figure with three female stick figures and three male stick figures to underscore the balanced gender ratio. To make certain that participants read the instructions and understood that the gender proportion was identical in the two companies, participants were asked to answer a multiple-choice question about the gender proportion. One participant got the question wrong and was taken back to the instructions. This participant got the question right on the second try.

Participants were then told about the objects they saw when they visited each company. A subset of the objects from Study 1 was chosen for this study. Participants were told that the first company had "Star Trek posters, soda cans, video games, comics, junk food, and technical magazines" (stereotypical environment), whereas the second company had "art posters, water bottles, nature photos, and general interest magazines" (nonstereotypical environment). Participants were asked to indicate which company they would choose (forced choice) and how likely they would be to join each company, on a scale ranging from 1 (*not at all*) to 7 (*extremely*). To measure ambient belonging, participants were asked how much they associated each object with themselves (asked at the end—see next paragraph), how similar they were to the employees in each company, and how much they thought they would fit in with the employees in each company (α for each environment = .74).

Participants then provided their ratings on how masculine/feminine they found each object (on a scale ranging from 1 [*associate more with males*] to 7 [*associate more with females*] but reverse scored for ease of interpretation such that greater numbers correspond to more masculinity; stereotypical environment α = .60; nonstereotypical environment α = .52) and how much they associated each object with themselves (Markus, 1977) (on a scale ranging from 1 [*not at all*] to 7 [*extremely*]; stereotypical environment α = .60; nonstereotypical environment α = .61). To confirm that the stereotypical objects were more highly associated with computer scientists than the nonstereotypical objects, participants also reported how much they associated each object with computer science majors (on a scale ranging from 1 [*not at all*] to 7 [*extremely*]; stereotypical environment α = .82; nonstereotypical environment α = .66). To assess other potential mediators, the same questions used previously for stereotype threat (stereotypical environment α = .91; nonstereotypical environment α = .91), how much their gender was valued in that company, and negativity of each object (stereotypical environment α = .68; nonstereotypical environment α = .57) were included. Controlling for these mediators did not alter the results presented below (see the *Considering alternative mediators* section). Participants ended the session by indicating background information, including ethnicity, gender, year in school, and major.

Results

Manipulation check. Confirming our pilot data in Study 1, participants more strongly associated computer science majors with the stereotypical objects (M = 4.66, SD = 1.12) than with the nonstereotypical objects (M = 3.14, SD = 0.92), $F(1, 83) = 70.92$, $p < .001$, $\eta_p^2 = .46$. A mixed-model 2 (gender) × 2 (environment: stereotypical, nonstereotypical) ANOVA revealed no significant interaction, $F(1, 83) < 1$, *ns*, that is men and women did not differ in their evaluation of stereotypicality.

Influence of environments on job choice. In line with Hypothesis 1, which predicted that group environments can determine who is interested in joining that group, participants' choice of company was influenced by the objects present in the environment. The proportion of women choosing the company with the stereotypical environment was much smaller than the proportion of men choosing that company (4/62; 6.5% vs. 8/23; 34.8%, respectively), $\chi^2(1, N = 85) = 11.11$, $p = .001$. A mixed-model 2 (gender) × 2 (environment: stereotypical, nonstereotypical) ANOVA on the continuous measure of interest revealed that participants generally preferred the company with the nonstereotypical environment (M = 5.61, SD = 1.40) over the stereotypical environment (M = 2.99, SD = 1.73), $F(1, 83) = 44.43$, $p < .001$, $\eta_p^2 = .35$. This main effect was qualified by a Gender × Environment interaction, $F(1, 83) = 10.03$, $p < .01$, $\eta_p^2 = .11$ (see Figure 2). Men rated themselves as more likely to choose the company with the stereotypical environment (M = 3.61, SD = 1.70) than women (M = 2.76, SD = 1.70), $F(1, 83) = 4.22$, $p < .05$, $\eta_p^2 = .05$, whereas women reported they were more likely to choose the company with the nonstereotypical environment (M = 5.94, SD = 1.21) than men (M = 4.74, SD = 1.51), $F(1, 83) = 14.22$, $p < .001$, $\eta_p^2 = .15$. In contrast to Study 1, men in this study preferred the company with the nonstereotypical environment to the one with the stereotypical environment, $F(1, 83) = 4.19$, $p < .05$, $\eta_p^2 = .05$, which was similar in direction to the pattern found for women, $F(1, 83) = 89.32$, $p < .001$, $\eta_p^2 = .52$. However, this preference for

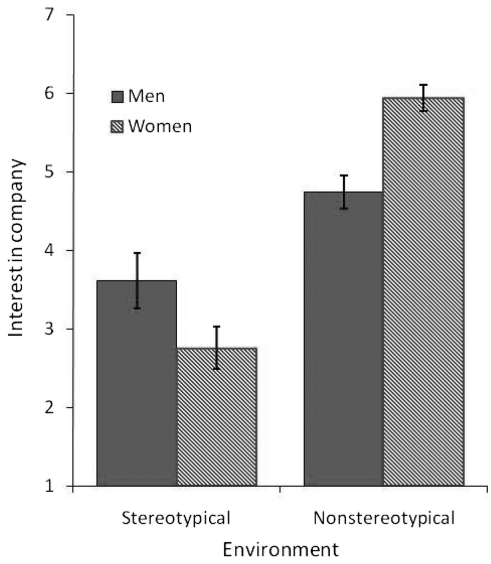

Figure 2. Interest in hypothetical postgraduation company by women (N = 62) and men (N = 23) in Study 3.

the company with the nonstereotypical over the stereotypical environment was stronger among women. (The 95% confidence intervals for the difference in interest between the two environments did not overlap: .03–2.22 for men and 2.51–3.85 for women).

Reactions to the stereotypical environment. To test Hypothesis 2, that environments project stereotypes, we conducted a mixed-model 2 (gender) × 2 (environment: stereotypical, nonstereotypical) ANOVA on ratings of masculinity. This analysis revealed a main effect of environment, $F(1, 83) = 418.06$, $p < .001$, $\eta_p^2 = .83$, such that the company with the stereotypical environment was rated as more masculine ($M = 5.43$, $SD = 0.52$) than the company with the nonstereotypical environment ($M = 3.19$, $SD = 0.61$). The Gender × Environment interaction was not significant, $F(1, 83) < 1$, *ns*; that is, men and women did not differ in how masculine they found the environments.

Perceived masculinity as a deterrent for women. Consistent with Hypothesis 3a, which predicted that perceiving an environment as masculine will deter women but not men, the more women perceived the stereotypical environment as masculine, the less interest they expressed in that company, $r(62) = -.31$, $p < .05$. For men, there was no relationship between perceived masculinity of the stereotypical environment and interest, $r(23) = -.06$, *ns*. Although perceived masculinity appeared to affect men's and women's interest differently, the interaction of perceived masculinity and gender (when entered into a regression along with masculinity and gender separately) was not significant ($b = -.79$, $SE = .81$, *ns*), which we speculate about in the *Discussion* section.

Perceived masculinity as a mediator for women. Next, we examined Hypothesis 3b, that ambient belonging mediates the relationship between perceived masculinity and interest for women. In Step 1, perceptions of masculinity predicted interest ($b = -1.00$, $SE = .40$, $p < .01$). In Step 2, perceptions of masculinity also predicted ambient belonging ($b = -.70$, $SE = .23$, $p < .01$). In Step 3, ambient belonging predicted interest when controlling for masculinity ($b = .77$, $SE = .20$, $p < .001$). And in Step 4, the relationship between masculinity and interest was eliminated when ambient belonging was controlled for ($b = -.46$, $SE = .39$, *ns*). The Sobel test revealed that ambient belonging was a significant mediator of the relationship between masculinity and interest among women ($Z = -2.33$, $p < .05$). We also tested the reverse mediation model: In Steps 3 and 4, interest predicted ambient belonging upon controlling for masculinity ($b = .26$, $SE = .07$, $p < .001$), but the relationship between masculinity and ambient belonging upon controlling for interest continued to be significant ($b = -.44$, $SE = .22$, $p < .05$). Our hypothesized mediation model therefore fit the data better than the reverse mediation model.

Ambient belonging as a mediator of the gender difference. In line with our predictions in Hypothesis 4, perceiving a greater sense of ambient belonging in the company with the stereotypical environment was related to increased interest in that company by both men, $r(23) = .52$, $p < .05$, and women, $r(62) = .51$, $p < .001$. However, men felt a greater sense of ambient belonging in the company with the stereotypical environment than did women (see Tabel 1).

To further test Hypothesis 4 and the role of ambient belonging as a mediator of the gender difference in interest, we conducted a mediation analysis (Baron & Kenny, 1986; Preacher & Hayes, 2004), which revealed that the relationship between gender and interest in the company with the stereotypical environment was fully mediated by ambient belonging in that environment. In Step 1, men expressed more interest in the stereotypical company than women ($b = -.85$, $SE = .41$, $p < .05$). In Step 2, men felt more ambient belonging in the stereotypical company than did women ($b = -.80$, $SE = .25$, $p < .01$). In Step 3, the relationship between ambient belonging and interest remained significant even after controlling for gender ($b = .86$, $SE = .16$, $p < .001$). In Step 4, gender was no longer related to interest upon controlling for ambient belonging ($b = -.16$, $SE = .38$, *ns*). A Sobel test revealed that ambient belonging was a significant mediator ($Z = -2.75$, $p < .01$). By contrast, testing the reverse mediation model revealed that interest did not fully account for the relationship between gender and masculinity: In Step 3, interest was a significant predictor of ambient belonging upon controlling for gender ($b = .30$, $SE = .06$, $p < .001$), but in Step 4, controlling for interest did not eliminate the relationship between gender and ambient belonging ($b = -.54$, $SE = .22$, $p < .05$). These results provide further

Table 1
Means, Standard Deviations, and Correlations Between Potential Mediators in Studies 2, 3, and 4

		Women						Men				
Mediator	Study	Stereotype threat	Gender valuation	Negativity	*M*	*SD*	*t*	*M*	*SD*	Stereotype threat	Gender valuation	Negativity
Ambient belonging	Study 2	$-.31^{\dagger}$	$.47^{**}$	$-.24$	2.68	1.43						
	Study 3	$-.05$	.09	$-.52^{***}$	2.49	1.00	3.25^{**}	3.29	1.03	$-.09$	.25	$-.63^{**}$
	Study 4	$-.28^{*}$	$.45^{***}$	$-.61^{***}$	2.79	1.00	7.34^{***}	4.55	1.07	$-.01$	$.43^{*}$	$-.60^{**}$
Stereotype threat	Study 2		$-.65^{***}$	$-.05$	3.22	1.58						
	Study 3		$-.39^{**}$	$.40^{**}$	3.08	1.35	-3.73^{***}	1.93	0.98		.02	.32
	Study 4		$-.36^{**}$	$0.23^{\dagger}$	4.13	1.46	-4.84^{***}	2.50	1.31		$.39^{\dagger}$	$-.28$
Gender valuation	Study 2			$-.25$	4.12	1.92						
	Study 3			$-.38^{**}$	3.27	1.52	6.42^{***}	5.48	1.04			$-.38^{\dagger}$
	Study 4			$-.59^{***}$	3.61	1.39	4.70^{***}	5.13	1.30			$-.38^{\dagger}$
Negativity	Study 2				4.15	1.21						
	Study 3				3.75	0.83	-1.49	3.44	0.86			
	Study 4				3.93	1.04	-1.63	3.54	0.93			

$^{\dagger} p < .10$. $^{*} p < .05$. $^{**} p < .01$. $^{***} p < .001$.

support for the hypothesized mediation model in which ambient belonging is a mediator of the relationship between gender and interest in the stereotypical company.

Discussion

Consistent with the previous two studies, we once again observed that stereotypes about groups can be communicated indirectly, simply through the objects that exist in that group's environment. The two companies in this study were identical in their gender proportion, salaries, and job descriptions; they differed only in the presence of a few objects, yet students again made a predictable choice regarding which company they would want to join, depending on their gender. For both men and women in this study, the more they felt a sense of belonging in a company, the more they wanted to work there. But in line with the previous studies, when the objects in the company were stereotypical of computer scientists, women felt less of a sense of belonging in the environment and, as a result, chose to forsake a future in that company to a greater extent than did their male counterparts. A lack of ambient belonging explained why women were less interested in the company with the stereotypical objects than men. Moreover, in addition to explaining the gender difference, in a pattern consistent with the previous study, a lack of ambient belonging explained why women who perceived the environment as particularly masculine were least interested in it.

In contrast to the previous study, men, like women, expressed an overall preference for the company with the nonstereotypical environment. One explanation may be that the stereotype does not appeal to men either. Indeed, the lack of a relationship between masculinity and interest among men suggests that the masculinity evoked by these environments does nothing to attract the types of men in our studies (i.e., those who have not already self-selected into computer science). However, this masculinity also does not repel them, as it does women. Because men's preference for the nonstereotypical environment over the stereotypical environment was weaker than women's, the result was still an underrepresentation of women expressing interest in the company with the stereotypical environment. Thus, changing the stereotype may help to attract more people—both men and women—into the field. This would be a boon to a field that is ardently seeking to increase the numbers of those who pursue it in order to keep up with the demands of society (National Academy of Sciences, 2005).

In the final study, we turned to the question of which environment—the stereotypical or the nonstereotypical (or both)—was driving the effect. We also addressed two limitations of the present study. First, in the present study, we made sure participants were aware that the gender proportion was identical across the two conditions by testing them *before* they saw the objects (meaning they might have forgotten or changed their mind about the gender proportion upon presentation of the objects). In the next study, we assessed knowledge about perceived gender proportion *before* and *after* they learned about the objects. Second, the interaction of gender and masculinity ratings of the environments on interest was not significant, which we surmised may have been due to our measure of masculinity—an average of masculinity ratings of each object in the environment—not being ideally suited to capturing differences in perceived masculinity of an environment as a whole. In the next study, we used a gestalt measure of masculinity, instead of asking about each object and averaging across them. Our final change was to bring the question of interest back to the domain of computer science by asking participants about their interest in a technology company.

Study 4: Which Environment Is Driving the Gender Difference in Interest and Why?

In Study 4, we once again tested the relationship between gender and interest. This time, however, we included baseline measures to assess whether the stereotypical or nonstereotypical environment was driving the effect. In addition, we made the following changes to our previous study: We (a) asked participants about perceived gender proportion before and after they learned about the objects; (b) used gestalt measures of masculinity and negativity (instead of asking about each object and averaging across them as we did in the previous study); and (c) assessed interest in a web design company.

Method

Participants. Ninety-seven students from the psychology participant pool at the University of Washington participated in this study for partial course credit. One computer science major was eliminated, leaving 96 participants (72 women).

Materials and procedure. Procedures were similar to the previous study, with the following exceptions. First, the companies were "web design" companies. Second, baseline measures (including interest, ambient belonging, stereotype threat, perceived gender valuation, negativity, and masculinity of the environment) were obtained before participants found out about the objects. Third, participants were asked about the gender proportion (which was stated on the previous screen as equal) before learning about the objects (89.6% correct) and after learning about the objects at each company (stereotypical: 88.5% correct; nonstereotypical: 96.9% correct). Participants who answered incorrectly were taken back to read about the company again and were required to answer the question correctly before continuing to the other measures. Fourth, an additional measure of interest was added; in addition to being asked how likely they would be to choose the companies, participants were asked how much they would want to work for the companies, on a scale ranging from 1 (*not at all*) to 7 (*extremely*) (baseline $\alpha = .87$; stereotypical environment $\alpha = .78$; nonstereotypical $\alpha = .94$). Fifth, participants rated the masculinity and negativity of the environments overall, in addition to rating individual objects, on a scale ranging from 1 (*very masculine/very negative*) to 7 (*very feminine/very positive*)—masculinity was reverse scored for ease of interpretation. Collapsing across the overall and individual object ratings had low construct reliability (αs $<$ .30 for both masculinity and negativity), so only the overall ratings were used. Questions on gender valuation, stereotype threat (baseline $\alpha = .88$; stereotypical environment $\alpha = .96$; nonstereotypical $\alpha = .93$), and ambient belonging (baseline $\alpha = .56$; stereotypical environment $\alpha = .83$; nonstereotypical $\alpha = .79$) were identical to the previous study, except that the baseline measure of ambient belonging did not include ratings of how much people associated themselves with the individual objects (because there were no objects at baseline). In a pattern identical to the previous two studies, controlling for the potential alternative mediators (gender valuation, ste-

reotype threat, and negativity) did not alter the results presented below (see the *Considering alternative mediators* section).

After completing the baseline measures, participants were told about the objects they saw when they visited each company (objects determined on the basis of pretesting described in Study 2).[4] Participants then completed the questions asked at baseline for each company. Participants ended the session by indicating background information (e.g., gender, major) and self-ratings of masculinity (there was no effect of this variable).

Results

The influence of environments on job choice. As predicted by Hypothesis 1, environments once again impacted participation. Women were much less likely to choose the company with the stereotypical environment (8/50; 16.0%) than were men (13/18; 72.2%), $\chi^2(1, N = 96) = 19.60$, $p < .001$. In a mixed-model 2 (between: gender) × 3 (within: baseline, stereotypical, nonstereotypical) ANOVA, there was no main effect of gender, $F(1, 94) < 1$, *ns*, but the company with the stereotypical environment generated less interest than the other two environments, $F(2, 93) = 11.02$, $p < .001$, $\eta_p^2 = .19$. This main effect was qualified by a significant interaction, $F(2, 93) = 18.64$, $p < .001$, $\eta_p^2 = .29$ (see Figure 3). We examined this interaction using simple effects tests comparing gender differences in interest within each environment. Interest did not differ between men ($M = 4.90$, $SD = 1.06$) and women ($M = 4.97$, $SD = 1.08$) at baseline, $F(1, 94) < 1$, *ns*. Interest in the company with the stereotypical environment was greater among men ($M = 4.96$, $SD = 1.38$) than among women ($M = 3.26$, $SD = 1.41$), $F(1, 94) = 26.34$, $p < .001$, $\eta_p^2 = .22$. In contrast, interest in the company with the nonstereotypical environment was greater among women ($M = 5.37$, $SD = 1.27$) than among men ($M = 3.54$, $SD = 1.50$), $F(1, 94) = 34.01$, $p < .001$, $\eta_p^2 = .27$.

Reactions to the stereotypical environment. To examine whether the stereotypical environment projected a masculine stereotype (Hypothesis 2), we conducted a mixed-model 2 (between: gender) × 3 (within: baseline, stereotypical, nonstereotypical) ANOVA on ratings of masculinity, which revealed a main effect of environment, $F(2, 93) = 52.98$, $p < .001$, $\eta_p^2 = .53$. The stereotypical environment was rated as most masculine ($M = 5.41$, $SD = 1.24$) followed by baseline ($M = 4.07$, $SD = 0.58$), and next by the nonstereotypical environment ($M = 3.01$, $SD = 1.04$). There was also a significant Gender × Environment interaction, $F(2, 93) = 6.35$, $p < .01$, $\eta_p^2 = .12$. Women were more extreme than men in their ratings of masculinity for the stereotypical environment (women: $M = 5.61$, $SD = 1.07$; men: $M = 4.79$, $SD = 1.53$), $F(1, 94) = 8.41$, $p < .01$, $\eta_p^2 = .08$, and in their ratings of femininity for the nonstereotypical environment (women: $M = 2.86$, $SD = 1.00$; men: $M = 3.46$, $SD = 1.06$), $F(1, 94) = 6.25$, $p = .01$, $\eta_p^2 = .06$. We did not observe this difference in our previous study and, in fact, did not observe this interaction of gender and masculinity when participants rated the masculinity of the individual objects in this study, $F(1, 94) < 1$, *ns*, which we speculate about in the *Discussion* section. Consistent with predictions, however, men still saw the company with the stereotypical environment as significantly more masculine than the company with the nonstereotypical environment, $t(23) = 8.22$, $p < .001$, $d = 2.54$.

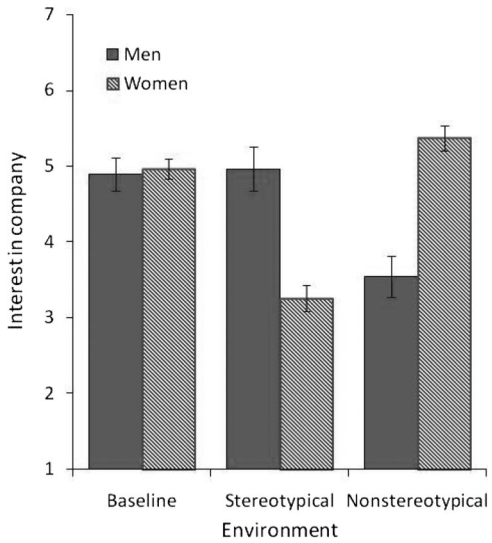

Figure 3. Interest in hypothetical postgraduation web design company by women ($N = 72$) and men ($N = 24$) in Study 4.

Perceived masculinity as a deterrent for women. Once again, in line with our prediction that a sense of incompatibility increases avoidance of that environment (Hypothesis 3a), the more women perceived the stereotypical environment as masculine, the less interested they were in that company, $r(72) = -.46$, $p < .001$. In contrast, for men, perceived masculinity was unrelated to their interest, $r(24) = -.16$, *ns.* The differing effect that perceived masculinity had on each gender was evidenced by a Gender × Masculinity interaction on interest ($b = -.47$, $SE = .23$, $p < .05$) and sense of ambient belonging ($b = -.36$, $SE = .16$, $p < .05$; when entering gender, masculinity, and the interaction term).

Ambient belonging as a mediator among women. Next, we tested Hypothesis 3b, whether ambient belonging mediated the relationship between masculinity and interest in the company with the stereotypical environment among female participants (Baron & Kenny, 1986; Preacher & Hayes, 2004).[5] In Steps 1 and 2, per-

[4] Participants were asked their opinions about the stereotypical environment before the nonstereotypical environment. A follow-up study ($N = 55$) in which we counterbalanced order of environments revealed that order of presentation did not influence any of the variables tested (i.e., choice of company, likelihood of choosing that company, masculinity ratings, and ambient belonging). Women preferred the nonstereotypical environment over the stereotypical environment, and men had no preference between the two, regardless of which environment was presented to them first.

[5] We also brought both genders and both environments into one within-subjects moderated mediation analysis to assess whether the *masculinity–ambient belonging–interest* mediation was moderated by gender. Using the moderated mediation techniques suggested by Preacher, Rucker, and Hayes (2007) and Judd, Kenny, and McClelland (2001), we found that the Gender × Masculinity interaction significantly predicted interest and ambient belonging (see main text). When controlling for ambient belonging, the Gender × Masculinity interaction no longer predicted interest ($b = -.05$, $SE = .16$, *ns*). We examined the mediation for women and men separately by examining the conditional indirect effects at different values of the moderator. For women, the mediation was significant ($p < .001$), whereas for men, the mediation was not significant. This analysis was consistent with our other analyses.

ceptions of masculinity predicted less interest ($b = -.61$, $SE = .14$, $p < .001$) and less ambient belonging ($b = -.48$, $SE = .10$, $p < .001$). In Step 3, controlling for masculinity did not eliminate the relationship between ambient belonging and interest ($b = 1.08$, $SE = .12$, $p < .001$). In Step 4, controlling for ambient belonging fully attenuated the relationship between masculinity and interest ($b = -.09$, $SE = .11$, *ns*; Sobel test: $Z = -4.35$, $p < .001$). Thus, in a pattern identical to the previous studies, ambient belonging fully mediated the relationship between perceived masculinity and interest for women. By contrast, in the reverse mediation model, interest was not a full mediator of the relationship between masculinity and ambient belonging: In Step 3, interest predicted ambient belonging upon controlling for masculinity ($b = .51$, $SE = .06$, $p < .001$), but in Step 4, masculinity continued to predict ambient belonging after controlling for interest ($b = -.17$, $SE = .07$, $p < .05$). The hypothesized mediation model, in which ambient belonging was a mediator, therefore once again proved a better fit for the data than the reverse causal path, which did not fully account for the relationship.

Ambient belonging as a mediator of the gender difference in interest. In line with our prediction underscoring the importance of ambient belonging (Hypothesis 4), ambient belonging in the stereotypical environment predicted interest in that company among both men, $r(24) = .83$, $p < .001$, and women, $r(72) = .80$, $p < .001$. Once again, however, men felt a greater sense of ambient belonging in the company with the stereotypical environment than women (see Table 1). In a manner identical to the previous study, we conducted a mediation analysis (Baron & Kenny, 1986; Preacher & Hayes, 2004) to examine whether the gender difference in interest in the company with the stereotypical environment was explained by the greater sense of ambient belonging that men felt in that environment than women. As predicted, the relationship between gender and interest in the company with the stereotypical environment was fully explained by the greater sense of ambient belonging that men felt there than women. In Steps 1 and 2, men were more interested in the stereotypical environment than women ($b = -1.70$, $SE = .33$, $p < .001$) and felt more ambient belonging there ($b = -1.76$, $SE = .24$, $p < .001$). In Step 3, ambient belonging predicted greater interest even upon controlling for gender ($b = 1.11$, $SE = .08$, $p < .001$). And in Step 4, controlling for ambient belonging eliminated the relationship between gender and interest in the stereotypical environment ($b = .26$, $SE = .25$, *ns*; Sobel test: $Z = -6.39$, $p < .001$). In the reverse mediation model, interest did not fully attenuate the relationship between gender and ambient belonging. In Step 3, interest predicted ambient belonging when controlling for gender ($b = .58$, $SE = .04$, $p < .001$), but in Step 4, the relationship between gender and ambient belonging remained significant upon controlling for interest ($b = -.77$, $SE = .16$, $p < .001$). Once again, consistent with the previous study, the reverse mediation model did not fit the data as well as the hypothesized model.

Discussion

We again found in this study that objects in an environment determined who entered the group. Women were drawn to an employment opportunity at a company whose environment contained objects not stereotypically associated with computer scientists, whereas men were drawn to a company whose environment contained objects that were associated with the stereotypical computer scientist. What was it about the stereotypical environment that signaled women to go elsewhere? Like the previous study, that environment evoked a masculine stereotype that compromised women's (but not men's) sense of ambient belonging and subsequently decreased their desire to be there. Lack of ambient belonging also again explained why those women who perceived the environment as particularly masculine were the most repelled by it. Replicating the findings of the previous two studies, the alternate explanations proved to be less viable than the hypothesized explanations.

There were three noteworthy differences between this study and the previous studies. First, women were less interested in the stereotypical environment than the baseline environment, whereas in Study 1, their interest did not differ between the stereotypical environment and baseline. Study 1 asked about interest in majoring in computer science, whereas this study asked about interest in working for a web design company. The computer science major may be seen as highly stereotypical, so the stereotypical objects may have added little new information about that domain. In contrast, a web design company may be seen as less associated with the computer science stereotype (indeed, women and men did not differ in their baseline interest), and the stereotypical objects may have provided new information about the masculinity of the company that drove women away. This suggests that environments have the power to dissuade women not only from a future in male-dominated computer science domains (like the computer science major) but also in other less male-dominated domains. The second interesting difference between this study and the previous one was that men were less extreme in their ratings of masculinity and femininity of the environments than women were. This may be because women tend to be more attuned to the presence of objects in an environment (McBurney, Gaulin, Devineni, & Adams, 1997); drawing participants' attention to each object individually (as in the previous study and the end of this study) eliminated the gender difference in perceived masculinity of the environments. The final interesting difference was that in contrast to the previous studies, men tended to avoid the nonstereotypical environment compared with both their baseline interest and interest in the stereotypical company. Domain may again play a role here. The combination of the web design company and the nonstereotypical objects may have appeared particularly feminine, and therefore threatening, to some men (Cheryan et al., 2009; Rudman & Fairchild, 2004; Vandello, Bosson, Cohen, Burnaford, & Weaver, 2008).[6]

Considering Alternative Mediators

To provide further evidence for our explanatory paths, that ambient belonging is the best candidate to explain why the masculinity of the stereotypical environment turns women away (Hypothesis 3b) and why women are less interested in the stereotypical

[6] In support of this, the more that men in Study 4 perceived the nonstereotypical web design environment as feminine, the less they felt a sense of ambient belonging in that environment, $r(24) = .60$, $p < .01$. By contrast, in Study 3, there was no relationship between perceptions of femininity of the generic company environment and ambient belonging for men, $r(23) = -.07$, *ns*.

environments than men (Hypothesis 4), we controlled for other possible mediators in Studies 2, 3, and 4. The first alternative explanation we examined was that the stereotypical environment heightened women's concern about being the target of stereotype threat, a type of social identity threat wherein the fear of being negatively stereotyped because of their social identity (Steele, 1997) can lead them to forsake the stereotyped domain (Davies et al., 2002). The second was that stereotypical cues made women feel that they would be devalued because of their gender (Adams, Garcia, Purdie-Vaughns, & Steele, 2006; L. L. Cohen & Swim, 1995; Gutek, Cohen, & Tsui, 1996; Pinel, 1999). A final explanation we controlled for was that women may find the stereotypical objects to be more negative than men find them and, as a result, become less interested in joining that group (Blanton et al., 2001) (see Table 1 for means and correlations between these potential mediators and ambient belonging). Our article is therefore the first, to our knowledge, to examine the relative contributions of belonging (Hannover & Kessels, 2004; Walton & Cohen, 2007), stereotype threat (Davies et al., 2002, 2005), perceived identity devaluation (Purdie-Vaughns et al., 2008), and perceived negativity in the context of the others.

We first assessed whether ambient belonging would continue to be a significant mediator of the relationship between perceived masculinity and interest among women (Hypothesis 3b) after controlling for the other potential mediators in Studies 2, 3, and 4. We conducted a mediation analysis with multiple mediators (Kenny, Kashy, & Bolger, 1998), using 1,000 bootstrap resamples using the SPSS macro developed by Preacher and Hayes (2008). In Step 1, perceived masculinity of the stereotypical team was related to less interest in that team (Study 2: $b = -.39$, $SE = .19$, $p < .05$; Study 3: $b = -1.00$, $SE = .40$, $p < .05$; Study 4: $b = -.61$, $SE = .14$, $p < .001$). In Step 2, perceived masculinity of the stereotypical team was related to lower ambient belonging (Study 2: $b = -.36$, $SE = .18$, $p = .05$; Study 3: $b = -.70$, $SE = .23$, $p < .01$; Study 4: $b = -.48$, $SE = .10$, $p < .001$), greater stereotype threat (Study 2: $b = .49$, $SE = .19$, $p < .05$; Study 3: $b = 1.01$, $SE = .31$, $p < .01$; Study 4: $b = .45$, $SE = .15$, $p < 01$), lower gender valuation (Study 2: $b = -.42$, $SE = .24$, $p = .09$; Study 3: $b = -.78$, $SE = .36$, $p < .05$; Study 4: $b = -.62$, $SE = .14$, $p < .001$), and greater negativity (Study 3: $b = .70$, $SE = .19$, $p < .001$; Study 4: $b = .35$, $SE = .11$, $p < .01$). In Step 3, the only mediator that predicted interest in the stereotypical team in all three studies upon controlling for masculinity and all the other mediators was ambient belonging (Study 2: $b = .69$, $SE = .15$, $p < .001$; Study 3: $b = .88$, $SE = .23$, $p < .001$; Study 4: $b = .98$, $SE = .14$, $p < .001$). In Step 4, the relationship between masculinity and interest was no longer significant upon entering the mediators (Study 2: $b = -.15$, $SE = .16$, *ns*; Study 3: $b = -.30$, $SE = .43$, *ns*; Study 4: $b = -.0004$, $SE = .12$, *ns*). In accordance with the analysis recommended by Preacher and Hayes (2008), ambient belonging was deemed a significant mediator because its 95% bias-corrected confidence interval did not include zero (Study 2: $-.75$ to $-.02$; Study 3: -1.40 to $-.16$; Study 4: $-.73$ to $-.26$). According to the pairwise contrasts generated by the macro (Preacher & Hayes, 2008), ambient belonging was a stronger mediator than perceived negativity in all three studies (with bias-corrected 95% confidence intervals of: $-.74$ to $-.02$ in Study 2, -1.51 to $-.27$ in Study 3, and $-.75$ to $-.19$ in Study 4), stereotype threat in two studies (with bias-corrected 95% confidence intervals of: -1.29 to $-.06$ in Study 3 and $-.75$ to $-.24$ in Study 4), and gender valuation in one study (Study 4: $-.64$ to $-.10$).[7] No other potential mediator tested as a stronger mediator than ambient belonging in any of the studies.

Next, we examined ambient belonging as a mediator of the relationship between gender and interest (Hypothesis 4) in Studies 3 and 4, controlling for the other potential mediators. In Step 1, being female was related to less interest in the stereotypical environment (Study 3: $b = -.85$, $SE = .41$, $p < .05$; Study 4: $b = -1.70$, $SE = .33$, $p < .001$). In Step 2, gender was related to three of the mediators: ambient belonging (Study 3: $b = -.80$, $SE = .25$, $p < .01$; Study 4: $b = -1.76$, $SE = .24$, $p < .001$), stereotype threat (Study 3: $b = 1.15$, $SE = .31$, $p < .001$; Study 4: $b = 1.63$, $SE = .34$, $p < .001$), and gender valuation (Study 3: $b = -2.20$, $SE = .34$, $p < .001$; Study 4: $b = -1.51$, $SE = .32$, $p < .001$). In Step 3, the only mediator that predicted interest in the stereotypical team upon controlling for gender and all the other mediators was ambient belonging (Study 3: $b = .84$, $SE = .20$, $p < .001$; Study 4: $b = .98$, $SE = .11$, $p < .001$). In Step 4, the relationship between gender and interest was fully explained upon entering the mediators as predictors (Study 3: $b = .09$, $SE = .48$, *ns*; Study 4: $b = .30$, $SE = .27$, *ns*). Ambient belonging was once again a significant predictor of interest because its 95% bias-corrected confidence interval did not include zero (Study 3: -1.18 to $-.23$; Study 4: -2.31 to -1.18). Pairwise contrasts revealed that ambient belonging was a stronger mediator than perceived negativity, with bias-corrected 95% confidence intervals that did not include zero (Study 3: -1.26 to $-.18$; Study 4: -2.36 to -1.14); ambient belonging was also a significantly stronger mediator than stereotype threat (Study 3: -1.24 to $-.06$; Study 4: -2.35 to -1.15) and gender valuation in Study 4 (-2.26 to $-.93$). (See Footnote 7.) None of the other three potential mediators were stronger mediators than ambient belonging.

Ambient belonging therefore was a powerful mediator of the effects, even after controlling for stereotype threat, feeling devalued in the domain, and perceived negativity. Why might stereotype threat, or the presence of negative stereotypes about women's abilities, not have been the best explanation for why stereotypical environments discourage women's participation? In Steele's (1997) conceptualization of stereotype threat, he suggested that stereotype threat most afflicts those who are highly identified with the domain (Schmader et al., 2008; see Shapiro & Neuberg, 2007, for potential exceptions). Unlike previous studies elucidating the role of threat in forsaking a domain (Davies et al., 2002; Murphy et al., 2007; Purdie-Vaughns et al., 2008), our participants were not highly identified with the domain and may have been more influenced by their impressions of the field than by the impressions that others may have of them. Thus, eliminating "situational factors that give rise to stereotype threat" (Davies et al., 2002, p. 1616) or more general concerns over being "treated negatively or devalued

[7] These results should be interpreted with caution because of existing correlations between some mediators (see Table 1), a circumstance that is very difficult to avoid in multiple mediation models (Preacher & Hayes, 2008). Correlated mediators are "not necessarily a problem" in multiple mediation models (Preacher & Hayes, 2008, p. 887) but may attenuate effects. Thus, the fact that ambient belonging emerged as the only viable mediator in these studies does not mean that the other potential mediators played no role in deterring interest among women.

in a setting simply because of a particular social identity they hold" (Murphy et al., 2007, p. 879) may not be enough to draw women into fields that are portrayed as incompatible with how they see themselves.

General Discussion

In the present research, when an environment stereotypically associated with computer science—containing video games, Star Trek memorabilia, and the like—was made salient, women were consistently less interested in joining the domain than men. This effect held across four different decisions (the computer science major, work teams, generic companies, and web design companies), three different gender representations (majority male, entirely female, and gender balanced), and two different methodologies (exposure to actual objects and imagining objects). Across three studies, we observed a consistent explanation for why these objects discouraged women's participation. Men and women saw the stereotypical environments as masculine. However, this masculinity compromised women's, but not men's, sense of ambient belonging, which led to less interest in pursuing the field. In fact, the women who perceived the environment as most masculine were consistently the least interested in joining it.

What happened when these objects were replaced with less stereotypical ones? When sitting in a nonstereotypical computer science environment that signaled less masculinity, women expressed more interest in the field. This aversion to the stereotypical environments by women was the case even when the gender proportion, salaries, work hours, and job description were identical across the two environments, demonstrating the power of environments to signal to people whether or not they should enter a domain.

Increasing Female Participation in Computer Science

A female Carnegie Mellon undergraduate interviewed about majoring in computer science announced that computer science was not for her because she did not "dream in code like they do" (Margolis & Fisher, 2002). Society has communicated to this young woman and countless others that they should dream in code, watch Star Trek, and read science fiction to be a computer scientist. Instead of changing the women who do not relate to this stereotype, our studies suggest that changing the field of computer science so that those who do not fit the present stereotypes feel that they have a place in the field will go a long way toward recruiting women. The present work shows that changing the stereotypes is possible and suggests a promising strategy. In our studies, a quick set up of a few objects in a computer science environment gave women the means by which to consider the field. The cost–benefit calculation is highly favorable; these are quickly and easily implementable adjustments with great potential for effecting desirable change.

But is it wise to overhaul present computer science environments if women will simply enter the field to be greeted by stereotypical objects and people who embody the stereotype? Those actually in the field claim that present stereotypes of computer scientists are highly exaggerated and inaccurate (Borg, 1999). However, the stereotype discourages those who do not relate to it from trying computer science, which in turn decreases the prevalence and salience of nonstereotypical environments. Breaking the cycle may therefore involve intentionally and overtly changing the stereotypes. Once women enter the field in greater numbers, the process will hopefully build on itself by further changing environments and stereotypes associated with computer scientists and subsequently attracting more women.

Changing the stereotypes of computer science may also encourage more men to enter computer science. Indeed, in each of our studies, there were many men, albeit fewer than women, who also favored the nonstereotypical environment over the stereotypical environment. Although their gender might not be incompatible with the masculinity of the stereotypical environment, other aspects of the stereotype—for instance, social awkwardness or an unhealthy obsession with computers (Cheryan & Plaut, 2009)—may discourage some men (and women) from considering a future in computer science. Across all studies, the degree to which people (both men and women) felt they belonged in the environment strongly predicted whether they chose to join that group, underscoring the importance of belonging in determining choices of members of underrepresented and overrepresented groups. Broadening the image of computer scientists to be inclusive of a greater variety of identities may therefore increase both women's and men's sense of ambient belonging and participation in computer science.

Conclusion

In four studies, we examined the role that stereotypical computer science environments play in communicating stereotypes and a sense of ambient belonging to potential majors. Our studies demonstrated that these environments broadcast a masculinity that made women feel like they do not belong in the field. However, when stereotypes of computer scientists were altered through the objects in the environment, women had the means and motivation with which to engage computer science as a possible future pursuit. Altering a group's image by changing their environments can therefore inspire those who previously had little or no interest in pursuing the group to express a newfound interest in it.

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