

LEARNING IN A MAN'S WORLD: EXAMINING THE PERCEPTIONS OF UNDERGRADUATE WOMEN IN MALE-DOMINATED ACADEMIC AREAS

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This study examined the perceptions of undergraduate women in male-dominated academic areas. First-year and final-year female undergraduates in a male-dominated academic area (i.e., math, science, or engineering) reported higher levels of discrimination and stereotype threat than women in a female-dominated academic area (i.e., arts, education, humanities, or social science), and men in either a male- or female-dominated academic area. Moreover, women in a male-dominated academic area were most likely to report thinking about changing their major. These findings suggest that female college students majoring in math, science, and engineering continue to perceive additional gender-based obstacles in their field.

It was just three years ago that the Massachusetts Institute of Technology released a report acknowledging discrimination against its female faculty (Massachusetts Institute of Technology, 1999). According to the report, female professors in male-dominated academic areas, such as math, science, and engineering, had received less salary, space, awards, and resources than their male counterparts. How do these accounts compare to the self-reported experiences of female students in male-dominated areas?

When entering college, more men than women typically enroll in the areas of math, science, and engineering (National Center for Education Statistics, 1997). Of those women who do enroll in these male-dominated academic areas, even fewer of them remain in math, science, or engineering by the end of their final year (National Science Foundation, 1999). Although women in 1994 received 46%,

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34%, and 16% of the bachelor's degrees awarded in math, science, and engineering, respectively, a much smaller percentage of doctoral degrees in math (22%), science (22%), and engineering (11%) were awarded to women (National Center for Education Statistics, 1997). In short, women are leaving these male-dominated academic areas at a much faster rate than men. But why?

There are, no doubt, a host of societal and psychological factors that may help to explain why many undergraduate women switch out of math, science, or engineering programs (see Eccles, 1987; Seymour & Hewitt, 1997). However, we believe two factors that are particularly important are sex discrimination and stereotype threat. Sex discrimination has been defined as "an unjustifiable negative behavior directed at a person on the basis of his or her sex" (Stephan & Stephan, 1996). According to Eccles' (1987) model of achievement-related choices, expectation for success is one of the main determinants of career choice. If undergraduate women in male-dominated academic areas perceive that they are currently being discriminated against because of their sex, or if they anticipate sex discrimination in their future career, they may lose confidence in their ability to succeed in this area and may choose to pursue another field of study.

A second factor that may help to explain women's attrition in male-dominated academic areas is stereotype threat: an uncomfortable feeling that arises when people are at risk of confirming a negative stereotype in the eyes of others (Spencer, Steele, & Quinn, 1999; Steele, 1997; Steele & Aronson, 1995). Women are well aware that gender stereotypes depict them as being bad at math and science

(Jones, Farina, Hastorf, Markus, Miller, & Scott, 1984). Consequently, if undergraduate women perform poorly on a math or science test, they may fear that others will attribute their poor test performance to their gender.

Clearly, both sex discrimination and stereotype threat may deter women from completing degrees in male-dominated academic areas. Indeed, women in math, science, or engineering may become "disidentified" with their academic area, defined as, "a re-conceptualization of the self and of one's values so as to remove the domain as a self-identity, as a basis of self-evaluation" (Steele, 1997, p. 614). In a laboratory experiment, Major, Spencer, Schmader, Wolfe, and Crocker (1998) examined disidentification among African American participants. Their results suggested that Black American students who feel threatened by negative stereotypes alleging their intellectual inferiority reduce the extent to which they derive their self-esteem from academic performance and may disidentify from their academic area.

Yet, undergraduate women in a male-dominated academic area have another option available to them. To avoid the threat of negative gender stereotypes, women in a male-dominated area may not decide to drop out of college entirely, but might instead choose to switch into a female-dominated academic area, such as social science.

The purpose of the present research, then, was to examine the experiences of undergraduate women in male-dominated academic areas, such as math, science, and engineering. We hypothesized that undergraduate women in a male-dominated academic area, such as math, science, or engineering, would be more likely than all other students to report that they: (1) are currently being discriminated against in their major because of their sex, (2) anticipate being discriminated against because of their sex if they were to pursue a career in a field related to their major, (3) feel more threatened by negative gender stereotypes suggesting that they are not as capable as men, (4) are least inclined to be identified with their specific field of study, and (5) are most likely to report thinking about changing their area.

METHOD

Participants

Participants were undergraduates from a private university in the northeastern United States. A total of 2,015 students, including 744 women and 605 men in their first year and 333 women and 333 men in their final year of university, were contacted by mail during the spring semester.¹ In writing, they were asked to complete a questionnaire for a chance to win a gift certificate in a lottery and were told that they could choose to omit any questions, or decide not to participate in the study at all. They were also reassured that all of their answers would be kept confidential. Participants who did not initially respond were sent a reminder

postcard, followed by a telephone reminder call. Re-mails were sent as requested.

The students who were contacted were a representative sample of the undergraduate population, with one exception; because of the nature of the study, we over-sampled women in their final year who were in a male-dominated academic area. Of the students who were contacted, 801 returned their questionnaire in the self-addressed, stamped envelope provided. Thus, the overall response rate was 39.8%, with 477 first-year students (35.4%) and 324 final-year students (48.6%) completing the questionnaire. A greater percentage of women (48.5%) who were contacted responded than men (29.7%). Consistent with the university's population, most students were White (70.4%) and from middle-class to upper-middle-class socio-economic backgrounds. The remaining students identified themselves as Asian (13.6%), Black (4.2%), or of a mixed or other racial category (11.8%).

Procedure

Students completed a questionnaire as part of a larger study about the aspirations and experiences of undergraduates. The key measures for the present study focused on self-reported current and future sex discrimination, stereotype threat, identification with their major, and their desire to change their major.

For the purposes of our analyses, it was necessary to determine which academic areas were male-dominated and which were female-dominated. We examined the *total* number of women enrolled in their final year at that university in each of five academic areas. We compared academic areas, as opposed to majors, primarily because undergraduates at this university are not required to declare a major until their second year. Accordingly, several first-year students ($N = 291$, 61.0%), had not yet decided on an exact major. First-year students who had not decided on their major were asked to choose the academic area that they would most likely major in. By contrast, first-year students who had chosen a major and all final-year students were simply asked to specify their major.

Consistent with societal stereotypes, we discovered that engineering (women = 29.2%), and math and science (women = 42.7%) were male-dominated areas, whereas arts (women = 60.6%), humanities (women = 59.3%), and social science (women = 57.5%) were female-dominated. Although several majors within math, science, and engineering were female-dominated, and several majors within arts, humanities, and social science were male-dominated, we chose to classify these according to the gender-distribution of the larger academic area for two reasons.² First, given the fact that the majority of the freshmen had not yet declared a major, this seemed to be the most effective way to categorize the students we sampled on the whole. Second, and perhaps most importantly, we kept these designations because they fit with the larger societal stereotypes, which indicate that engineering, math, and science are

more male-dominated, and that the arts, social sciences, and humanities are more female-dominated.

Measures

Current and future sex discrimination. The extent to which students felt they were currently being discriminated against because of their sex was assessed using a combination of two questions adapted from the single-item attribution measure used by Crocker, Voelkl, Testa, and Major (1991). Each participant was asked, "To what extent are you discriminated against in your major because of your gender?" followed by, "To what extent are students of your same gender discriminated against in your major because of their gender?" In order to assess the amount of sex discrimination that students anticipated in the future, participants were asked, "If you were to pursue a career in a field related to your major, to what extent do you believe you would be discriminated against because of your gender?" and "If other students of your same gender were to pursue a career in a field related to your major, to what extent do you believe they would be discriminated against because of their gender?" Students answered each of these questions by making a rating on a scale from 1 (*not at all*) to 5 (*a lot*). Our decision to assess both the personal and group targets of sex discrimination was based on previous research showing a discrepancy between self-reported personal and group discrimination (see Taylor, Wright, Moghaddam, & Lalonde, 1990).

Stereotype threat. To measure the degree to which students reported feeling threatened because of negative stereotypes alleging their intellectual inferiority in their academic area, they were asked to complete a series of eight items adapted from the Stereotype Vulnerability Scale (SVS; Spencer, 1993). This scale has been shown to have relatively good internal consistency, both in previous work by Spencer (Cronbach's alpha = .67) and in the present study (Cronbach's alpha = .84). Students were asked to think about classes in their major and rate from 1 (*never*) to 5 (*almost always*) how often they feel that because of their gender "some people believe that you have less ability," and "professors expect you to do poorly."

Identification with major and desire to change major. We assessed the extent to which students identified with their major by asking them to rate from 1 (*not at all*) to 5 (*a lot*) how much they like their major and how good they are in their major. Students also answered four questions of identification, such as "How much does your performance in your major relate to your sense of who you really are?" adapted from Major et al.'s (1998) measure. In the present study, these six items showed good internal consistency (Cronbach's alpha = .72).

To assess their desire to change major, first-year students were asked to report how often they think about changing their major, whereas final-year students were asked to re-

port how often they had thought about changing their major, using the same 5-point scale.

RESULTS

For each of our five dependent variables, we performed a 2 (Sex of Student: male, female) X 2 (Academic Area: male-dominated, female-dominated) ANOVA. This was followed by a focused contrast (*t*-test) to test our hypotheses that women in male-dominated areas (contrast weight of +3) would feel more current and future discrimination, stereotype threat, disidentification with their major, and desire to change their major than men in male-dominated majors (contrast weight of -1), men in female-dominated majors (contrast weight of -1), and women in female-dominated majors (contrast weight of -1).³ Table 1 displays the means and standard deviations for each of these dependent measures.

The ANOVA on the two-item measure of *current sex discrimination* yielded a main effect for Sex of Student, $F(1, 748) = 41.36, p < .001$, and Academic Area, $F(1, 748) = 13.66, p < .001$, as well as the anticipated Sex of Student X Academic Area interaction, $F(1, 748) = 17.96, p < .001$. Furthermore, consistent with our first hypothesis, results from the contrast analysis indicated that women in a male-dominated academic area were most likely to report that they were currently being discriminated against because of their sex, $t(748) = 7.89, p < .001$.

As with current sex discrimination, the ANOVA for the two-item measure of *future sex discrimination* yielded main effects for Sex of Student, $F(1, 747) = 206.01, p < .001$, and Academic Area, $F(1, 747) = 17.66, p < .001$, as well as the anticipated Sex of Student X Academic Area interaction, $F(1, 747) = 10.62, p < .001$. In addition, in line with our second hypothesis, the contrast analysis indicated that women in a male-dominated academic area were most inclined to report that they would be discriminated against because of their sex if they were to pursue a career in a related area in the future, $t(747) = 11.97, p < .001$.

For our measure of *stereotype threat*, we used the average of the eight ratings that students made on the SVS (Spencer, 1993). The ANOVA using this dependent measure revealed main effects for Sex of Student, $F(1, 740) = 57.52, p < .001$, and Academic Area, $F(1, 740) = 16.13, p < .001$, although these main effects were qualified by the expected Sex of Student X Academic Area interaction, $F(1, 740) = 13.91, p < .001$. Consistent with our third hypothesis, the contrast revealed that women in a male-dominated academic area were most likely to report feeling threatened by negative gender stereotypes in their major, $t(740) = 8.40, p < .001$.

We examined students' *identification with their major* using a composite of the six separate ratings that students made of identification as our dependent measure, where lower scores indicated less identification. A main effect for

Table 1

Means and Standard Deviations for Perceived Current Sex Discrimination, Future Sex Discrimination, Stereotype Threat, Identification with Major, and Desire to Change Major

Measure	Male-Dominated Academic Area		Female-Dominated Academic Area		Focused Contrast <i>p</i> (One-Tailed)
	Women	Men	Women	Men	
Current Sex Discrimination	1.57 (0.84)	1.11 (0.45)	1.23 (0.48)	1.13 (0.36)	<.001
Future Sex Discrimination	2.36 (1.02)	1.19 (0.59)	1.87 (0.95)	1.13 (0.35)	<.001
Stereotype Threat	1.72 (0.69)	1.25 (0.53)	1.40 (0.49)	1.24 (0.35)	<.001
Identification with Major	3.52 (0.61)	3.45 (0.71)	3.65 (0.63)	3.50 (0.67)	>.40
Desire to Change Major	2.54 (1.36)	2.41 (1.25)	2.42 (1.35)	2.04 (1.10)	<.05

Note: All ratings ranged from 1 to 5. Numbers in parentheses are standard deviations. For Identification with Major we anticipated that women in a male-dominated academic area would report a *lower* level compared to all other students. For the four remaining measures, we hypothesized that women in a male-dominated academic area would report a *higher* level relative to all other students.

Sex of Student emerged, $F(1, 730) = 4.64$, $p = .03$, and the main effect for Academic Area approached significance, $F(1, 730) = 2.80$, $p = .10$; however, the anticipated interaction was not significant, $F(1, 730) = .72$, $p = .40$. Similarly, the contrast revealed that, contrary to our fourth hypothesis, women in a male-dominated academic area were not any less identified with their specific field of study than were the other students, $t(730) = .20$, $p = .42$.

Finally, we examined the extent to which students thought about *changing their major*. For this ANOVA, a main effect for Sex of Student emerged, $F(1, 745) = 6.22$, $p = .01$, as did a main effect for Academic Area, $F(1, 745) = 5.67$, $p = .02$; however, the anticipated Sex of Student X Academic Area interaction did not reach significance, $F(1, 745) = 1.45$, $p = .23$. Nevertheless, in keeping with our fifth hypothesis, the more focused contrast revealed that women in a male-dominated academic area were, in fact, most likely to report thinking about changing their area, $t(745) = 2.02$, $p < .05$.

DISCUSSION

The results of the present study met all but one of our expectations. Just as we anticipated, undergraduate women in a male-dominated academic area, such as math, science, or engineering perceived higher levels of sex discrimination directed at themselves personally, and toward women in general, in their major than any other students. Similarly, these women reported anticipating the most sex discrimination for themselves and for other women, if they were to pursue a career in their major.

Interestingly, although this difference in self-reported current sex discrimination emerged as expected, women's ratings on this measure were relatively low, with mean ratings always remaining below the midpoint of the scale. This could suggest that discrimination against undergraduate women is no longer as serious a problem; however, caution should be used in drawing this conclusion, as these results could be a product of our sample. First-year students might

not have had sufficient opportunity to encounter discrimination, and final-year students who have faced discrimination might have switched out of their male-dominated major in an earlier year, leaving us to sample only those final-year students who encountered little discrimination.⁴ In addition, because we did not provide a definition of sex discrimination prior to our questions, it is difficult to discern how each student interpreted this term when responding.

The results for stereotype threat also met our expectations, in that undergraduate women in math, science, or engineering were most likely to report feeling threatened by negative gender stereotypes that allege they are not as capable as men. Interestingly, as can be noted from the means in Table 1, this feeling of threat was not similarly expressed by men majoring in female-dominated academic areas. Although men are currently a minority in certain academic areas, they have not historically been negatively stereotyped or discriminated against in these domains because of their gender, and accordingly, it is perhaps not surprising that their experience differs from those described by women in male-dominated areas.

Contrary to our expectations, undergraduate women in math, science, or engineering were no less identified with their specific field of study. However, in keeping with our expectations, female students in math, science, or engineering were most likely to report thinking about changing their major. Although this result, when combined with our other findings, may seem to suggest that higher levels of perceived sex discrimination and stereotype threat lead undergraduate women to switch out of these male-dominated academic areas, caution must be used in drawing this conclusion. While undergraduate women in math, science, and engineering did report the highest level of current sex discrimination, future sex discrimination, and stereotype threat, our study is limited in that we are unable to draw a causal link from these data. Longitudinal research will be needed to determine whether these factors can really explain women's under-representation in these fields.

In conclusion, the findings of this study suggest that the perceptions of female students in math, science, and engineering are not unlike the realities faced by the female faculty at the Massachusetts Institute of Technology (see Massachusetts Institute of Technology, 1999). Although these results suggest continued inequalities for women entering into their male-dominated majors, it is reassuring to note that in the last few decades, more women have been entering, and completing university degrees in math, science, and engineering (Sonnert, 1998). It is our hope that as these fields become more gender-neutral, perceptions of sex discrimination and stereotype threat will decline among undergraduate women.

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NOTES

1. Students' year of study had no particular significance for our study. These particular years were chosen for reasons related to other portions of the research. Accordingly, this variable was not included in our analyses.
2. Exceptions included biology, chemistry, and chemical engineering that were female-dominated among all final-year students, math, which was even split between the sexes, and economics, history, music, and philosophy that were male-dominated among all final-year students.
3. All focused contrast p -values are one-tailed. For more information on contrast analysis, please see Rosenthal and Rosnow (1991).
4. Thank you to an anonymous reviewer for pointing this out.

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