The Impacts of Stereotypical and Counter-Stereotypical Imagery on Female and Male Students: Lessons for Implementation

ABSTRACT

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1 Background

Despite high wages, favorable working conditions, and strong demand for workers, the number of women obtaining degrees in technology and engineering has been in steady decline since the 1980s. The reasons for women's underrepresentation in technology degree programs include their lack of exposure to technology, lower intellectual self-confidence, and lower tolerance for risk (Corbett and Hill, 2015; Margolis and Fisher, 2002; Margolis, 2008; Sax, 2008; Butterfield and Crews, 2012). While gender-based exposure, self-confidence, and risk tolerance help to explain why women are less likely to choose a technology pathway, women who overcome these barriers and pursue technology may encounter an additional deterrent: situational threats. Situational threats, referred to as social identity threats by psychologists, arise in situations where women expect to be devalued on the basis of their gender (Murphy et al., 2007). College women who perceive an identity-based threat are less likely to show continued interest in technology.

This study reports on an intervention designed to increase college women's participation in technology. As part of a large-scale, randomized experiment, college freshmen were encouraged by an academic advisor to consider technology courses and were provided with an informational brochure on technology course offerings. Students in the treatment group received one of three brochures, which varied by the representation of men and women featured in the imagery. We compare men and women who received all-female or all-male brochures, relative to students who received mixed-gender brochure. We find that women were more likely to enroll in a technology courses, but did not exhibit differences by imagery. Men were more likely to enroll with the all-male brochure, and much less likely to enroll with the all-female brochure. To provide guidance for the implementation of similar policy designs in the future, we consider possible explanations for students' responses to the different brochures.

2 Research Design

The experiment described below was implemented with approximately 4,000 incoming freshman attending new student orientation at the flagship campus of a Midwestern state university. Students attended orientation in a series of two-day cohorts, with approximately 250 students in each cohort. Students were randomly assigned to treatment and control groups based on the start date of the two-day orientation cohort that they joined.

On the first day of each two-day orientation session, students attended a planning workshop in which they received an overview of the degree attainment process and prepared a list of planned courses for their first semester. During the workshop, students were provided with a planning worksheet and a list of open courses that do not require prerequisites. Students in the control group used the list and other materials to complete the worksheet, which became the basis for registration on the second day of orientation.

Students in the treatment group received the same materials as the control group, but also received a large, glossy brochure that markets technology courses across a variety of academic areas. The list of technology-focused courses inside the brochure was organized by the type of general education requirement fulfilled (e.g., Arts and Humanities, Natural and Mathematical, etc.). The back of the brochure included elective courses of potential interest to students in a variety of majors. The planning workshop was facilitated by an academic advisor, who distributed the brochure and encouraged students to consider that technology skills are useful for any major, do not require prior experience, and can help to expand students' opportunities.

Images on the inside of the brochure provide a non-stereotypical presentation of students interacting with technology in order to counter the stereotype of technology as masculine. To evaluate the effects of this imagery on students' enrollment decisions, we assigned students in the treatment group to one of three brochure conditions: a non-stereotypical (control) condition with mixed-gender imagery, a stereotypical condition with images of only men interacting with technology, and a counter-stereotypical condition with images of only women interacting with technology.

3 Data Collection

The university provided admissions data, demographics, and enrollment records for each student. The outcome variable is a binary indicator for whether the student enrolled in any technology course. The treatment variables were coded to represent the different situational contexts on the basis of treatment arm assignments. We included indicator variables for each treatment arm based on the imagery in each brochure. The all-female imagery arm represents the counter-stereotypical condition, the all-male imagery arm represents the stereotypical condition, and the mixed-gender imagery indicator is included to represent the baseline.

Table 1: Descriptive Statistics and Covariate Balance: Treatment Arms

	Control	Mixed	Arm F	vs. Mixed	Arm M	vs. Mixed
Female	0.500	0.520	0.505	−0.014	0.502	−0.018
	0.500	0.500	0.500		0.500	
Minority	0.115	0.105	0.113	0.008	0.110	0.005
	0.319	0.307	0.316		0.313	
Age	18.424	18.379	18.412	0.033*	18.385	0.006
	0.510	0.384	0.461		0.400	
Ability	24.704	24.791	24.480	−0.311**	24.490	−0.302**
	2.995	3.075	2.978		2.960	
N	1,377	1,295	924		584	

Standard deviations reported below means; *p<0.10; **p<0.05; ***p<0.01

4 Data Analysis

Let Y_i^* be a continuous latent variable for which we only observe the outcome, Y_i, enrollment in a technology course:

$$Y_i = \begin{cases} 1, & \text{if enrolled} \\ 0, & \text{otherwise} \end{cases}$$

The probability of enrolling in a technology course can be estimated as follows:

$$Pr(Y_i) = \text{logit}^{-1}(\beta_0 + \beta_k X_k) = \frac{\exp(\beta_0 + \beta_k X_k)}{1 + \exp(\beta_0 + \beta_k X_k)}$$

where X_k represents the set of predictors.

The data generation process involved students attending one of 23 new student orientation cohorts, interacting with an academic advisor, and choosing courses based on those interactions. As a result, students' enrollment decisions may be influenced by cohort or advisor factors or both.

To address the lack of independence between observations, we specified a mixed-effects generalized linear model, as follows:

$$
\begin{aligned}
logit(Y_e) = \beta_{0[i]} &+ \beta_1(\text{Mixed}) + \beta_2(\text{Arm F*Female}) + \beta_3(\text{Arm M*Female}) \\
&+ \beta_4(\text{Arm F*Male}) + \beta_5(\text{Arm M*Male}) + \beta_6(\text{Female}) \\
&+ \beta_7(\text{Minority}) + \beta_8(\text{Age}) + \beta_9(\text{Ability}) + \beta_{10}(\text{Term Day})
\end{aligned}
$$

where $\beta_{0[i]}$ is the set of random intercepts for each student.

5 Findings

Students have many courses to choose from, and the brochure comprises approximately 30 courses across fields, so the probability of enrolling in one of those courses is small, ranging from about 1.5% to 5%. Comparing men and women in the control group, the probability that any single course enrollment will be in technology is more than twice that of women. Receiving the intervention with the mixed-gender brochure led to increases in the probability of technology enrollment for both men and women, but the increase in probability is greater for men (0.94 ppt) than it is for women (0.43 ppt). For women, the all-female and all-male arms suggest a slightly smaller probability of enrolling, but these differences were not statistically significant from zero. For men who received an all-female brochure were about as likely to enroll in a technology course as men in the control group, while men who received the all-male brochure were more likely to enroll in a technology course than any other group of students.

6 Conclusions

The results suggest that changes to the situational context do not fully explain gender differences. For women, the intervention made a significant different in technology enrollment, but the specific brochure did not matter. This suggests that the intervention appealed to women's preferences or operated by some mechanism other than the situational context. For men, the results were not explained by situational context theories, given the strong negative response to the all-female imagery and the small positive response to the all-male imagery, relative to the mixed-gender brochure. Of the studies pertaining to the effects of domain stereotypes on interest and participation, only one study found negative effects on men (Cheryan and Plaut, 2010). However, in contrast to this study, the authors found that men's lack of interest in the domain was predicted by dissimilarity with those in a female-dominated field, where men are under-represented. This study finds that changes to the social context can decrease men's participation in technology, where men are over-represented.

Table 2: Technology Enrollment Take-up Rates by Gender and Condition

Panel A							
Female	Mixed	Arm F	vs. Mixed	% Diff.	Arm M	vs. Mixed	% Diff.
Enrolled	128	100	28		63	65	
Not Enrolled	545	367	178		230	315	
Total	673	467	206		293	380	
% Enrolled	19.02%	21.41%	2.39 ppt	12.57%	21.50%	2.48 ppt	13.03%

Panel B							
Male	Mixed	Arm F	vs. Mixed	% Diff.	Arm M	vs. Mixed	% Diff.
Enrolled	223	146	77		105	118	
Not Enrolled	383	302	81		178	205	
Total	606	448	158		283	323	
% Enrolled	36.80%	32.59%	-4.21 ppt	-11.44%	37.10%	0.30 ppt	0.82%

Panel C							
All	Mixed	Arm F	vs. Mixed	% Diff.	Arm M	vs. Mixed	% Diff.
Enrolled	351	246	105		168	183	
Not Enrolled	928	669	259		408	520	
Total	1,279	915	364		576	703	
% Enrolled	27.44%	26.89%	-0.56 ppt	-2.04%	29.17%	1.72 ppt	6.27%
M-F Gap	17.78 ppt	11.18 ppt			15.60 ppt		

Table 3: GLMM Estimates of Treatment Effects

	Enrollment
Mixed	0.2618***
	(0.0833)
Arm F — Female	0.0625
	(0.1759)
Arm M — Female	−0.0841
	(0.2149)
Arm F — Male	0.1260
	(0.1211)
Arm M — Male	0.3141**
	(0.1456)
Female	−0.8268***
	(0.0723)
Minority	0.0103
	(0.1002)
Age	−0.0309
	(0.0313)
Ability	0.1084***
	(0.0365)
Term Day	−1.0660***
	(0.0308)
Constant	−3.3697***
	(0.0679)
Observations	47,419
Log Likelihood	-11,502.4900
Akaike Inf. Crit.	23,028.9800
Bayesian Inf. Crit.	23,134.1900
Note:	*p<0.1; **p<0.05; ***p<0.01

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