#iLookLikeAnEngineer: Improving Student Outcomes by Reducing STEM Stereotypes

Although women obtain the majority of U.S. undergraduate degrees in STEM (science, technology, engineering, and math), they earn less than 20% of undergraduate degrees in computer science and engineering (National Science Foundation, 2013). Stereotypes about these specific fields that uniquely conflict with stereotypes about women are one reason for this gap (Cheryan, Master, & Meltzoff, 2015): computer scientists and engineers are stereotyped as socially-awkward, isolated, geeky men with masculine interests (e.g., videogames; Mercier, Barron & O'Connor, 2006; Rommes, Overbeek, Scholte, Engals, & De Kemp, 2007). Additionally, the work itself is perceived as requiring innate brilliance (Leslie, Cimpian, Meyer & Freeland, 2015) and removed from communal values such as helping society and working with others, goals women endorse more than men (Diekman, Brown, Johnston, & Clark, 2010). Many of these stereotypes are formed from media depictions of scientists (Cheryan, Plaut, Handron, & Hudson, 2013; Steinke et al., 2007). The proposed research tests the efficacy of a popular, ongoing movement—the #iLookLikeAnEngineer campaign—to alter these harmful stereotypes. Specifically, we will use an intervention paradigm to examine the efficacy of the #iLookLikeAnEngineer campaign to minimize students' stereotypes of engineers and thereby bolster their sense of belonging and intentions to persist in engineering. This project will also provide necessary data for a larger grant focusing on dissemination of the intervention, and bring psychological perspectives to bear on STEM education, recruitment, and retention at CU-Boulder.

Background and Motivation

The #iLookLikeAnEngineer hashtag became viral on Twitter after Isis Wenger, a female engineer featured in her company's recruitment campaign, experienced criticism and backlash on the Internet. Essentially, her status as an engineer was questioned because she was "too attractive" to be a "real engineer" (Figure 1, left panel). In response, she posted her photo accompanied by the hashtag "iLookLikeAnEngineer" (Figure 1, right panel), and encouraged other engineers to do the same to challenge notions of what engineers are "supposed to" look like (Zamon, 2015). Since then, hundreds of people have responded, their photos featuring the hashtag, descriptions of their engineering skills, and often personal information that counters engineer stereotypes (see Figure 2). Various educational bodies and engineering firms have embraced the hashtag in their advertisements, and billboards of the campaign have recently appeared in San Francisco.

Figure 1. Isis Wenger in the original ad that drew criticism (left panel) and posting her photo with the hashtag #iLookLikeAnEngineer (right panel).

Isis Wenger's experience is far from unique. Over a 5-year period, 80% of female and 72% of male undergraduate engineering majors surveyed agreed that the belief that women in science or technical fields are unfeminine is a problem for women pursuing these careers; the more that a woman perceived that this was a problem, the less satisfied she was in her field (Hartman & Hartman, 2008). Women in STEM environments have reported feeling unable to present themselves in a stereotypically feminine manner (e.g., wearing a skirt, expressing emotions) because they do not want to draw attention to their gender or are apprehensive that they will seem unsuitable for a STEM career (Hewlett, Luce, & Servon, 2008; Pronin, Steele, & Ross, 2004). Recent research from our lab demonstrated that actual female scientists with increasingly feminine appearance were judged as less likely to be scientists. In contrast, gendered appearance had no affect on judgments of male scientists (Banchefsky, Westfall, Park, & Judd, 2016; Evans, 2016).

The #ILookLikeAnEngineer campaign diverges from most attempts to alter STEM stereotypes because it exposes people to numerous examples of engineers—some who may fit engineering stereotypes and some who may not—in an attempt to broaden and diversify the stereotype. The movement is intended to celebrate and showcase the breadth and diversity of engineers in a variety of ways: in terms of gender, race, age, and physical appearance (see Figure 2). The inclusiveness of this approach should not only attract more women and minorities to the field, but should also be inviting to men who do not fit narrow STEM stereotypes. In contrast, research that exposes people to a single counter-stereotypic individual has largely failed to inspire greater interest in pursuing STEM (Betz & Sekaquaptewa, 2012; Cheryan, Drury, & Vichayapai, 2012), likely because the single person is deemed an unusual "exception to the rule", and thus does not change STEM stereotypes (Fiske & Neuberg, 1990; Kunda & Oleson, 1995). Efforts to change the broader image of STEM are more promising; for example, when women read that computer scientists were becoming less "geeky" compared to the past (although 1/3 still described themselves as "geeks"), they became more interested in pursuing computer science (Cheryan et al., 2013).

The proposed research will directly test the efficacy of this campaign to reduce engineer stereotypes, thereby increasing belonging and intentions to persist in engineering among men and women early in their STEM trajectory at CU-Boulder. We hypothesize that exposure to this campaign will a) weaken STEM stereotypes, (b) increase the perceived similarity between the self and people in STEM careers, (c) increase sense of belonging in engineering, and (d) improve intentions to persist in engineering as well as performance outcomes in engineering (e.g., GPA). Finally, we will assess whether the campaign is especially effective for women relative to men.

Figure 2. Examples of the #iLookLikeAnEngineer campaign.

Methodology

Participants. In the summer of 2016, we will coordinate with professors and teaching assistants who teach large, introductory gateway courses to engineering at CU-Boulder (e.g., PHYS

1110, APPM 1350). My supervisor, Dr. Tiffany Ito, and I have experience conducting research with students in these courses and have several contacts with professors within the relevant departments. Students will be randomly assigned to partake in the #iLookLikeAnEngineer intervention or a control based on their recitation section.

Study Design. To assess the longitudinal impact of the intervention, we will collect questionnaire measures at three time points: two weeks into classes (baseline), four weeks into classes (intervention/control) and the last week of classes (post-test). For students who permit access, we will also obtain their transcripts from CU. Important psychological factors associated with academic success will be measured at each time point (see Table 1). Baseline and post-test measures will be collected online via a survey link that will be sent to all students in the course. Participation in the research will be voluntary. The intervention/control measures will be collected in person during the recitation section. We are using this longitudinal design because it enables an examination of how variables change from the beginning to the end of the semester, and critically, whether their trajectory depends on exposure to the #iLookLikeAnEngineer campaign. In a Fall 2015 study we conducted with PHYS 1110 students, participation was voluntary and the response rate was approximately 70%. We expect a similar response rate in the proposed study.

Table 1. Intervention Timeline.

	Phase 1	**Phase 2**	**Phase 3**	
	Baseline	**Intervention/ Control**	**Post-Test**	**Follow-Up**
Timing	Week 2	Week 4	Week 15	1 and 3 semesters post-intervention
Measures	-Demographics -Stereotypes -Belonging, identity, similarity	-Stereotypes -Belonging, identity, similarity -Familiarity with campaign	-Stereotypes - Belonging, identity, similarity -Intent to Persist	-STEM GPA -# STEM courses -Major change

Note. Stereotypes consist of traits typical of engineers, necessity of brilliance with engineering success, and the extent to which engineering affords communal goals.

Intervention Materials. The intervention presentation will be a 30-minute interactive lecture designed according to the components of effective scientific diversity interventions (Moss-Racusin et al., 2014). The presentation will have three aims: 1) Define stereotypes and discuss their origin, with a focus on engineering stereotypes and how they are oversimplified and inaccurate (Borg, 1999); 2) explore strategies to minimize stereotypes, with a focus on concepts captured by the #iLookLikeAnEngineer campaign (e.g., exposure to counter-stereotypes); 3) engage the students by enabling them to become part of the campaign. Specifically, students will have the opportunity to partake in a photo-shoot in which I take their photo while they hold a sign with the hashtag and a proclamation of their choice (e.g., about their engineering skills, interests, or hobbies outside of STEM). Prior to finalizing the intervention, it will be tested among expert social psychologists and undergraduates enrolled in Introduction to Psychology. It will also be more formally tested in several focus groups with undergraduates in engineering.

Students who are assigned to the control condition will not receive the #iLookLikeAnEngineer intervention but, in order to hold as many factors constant as possible across the intervention and the control group, will still participate in an interactive lecture during their recitation section. The topic and precise content of this lecture will be decided after discussing with course professors and teaching assistants what would be most practical and useful for the students (e.g., a discussion of the growing opportunities for engineering in the Boulder area, a discussion of resources available to engineers at CU). I am qualified to conduct the interventions and have extensive experience moderating discussions of sensitive topics (including stereotyping and prejudice) as the primary instructor for Introduction to Social Psychology.

Hypotheses and Measures. Hypotheses are visualized in Figure 3. Example items for the questionnaire are presented in Table 2.

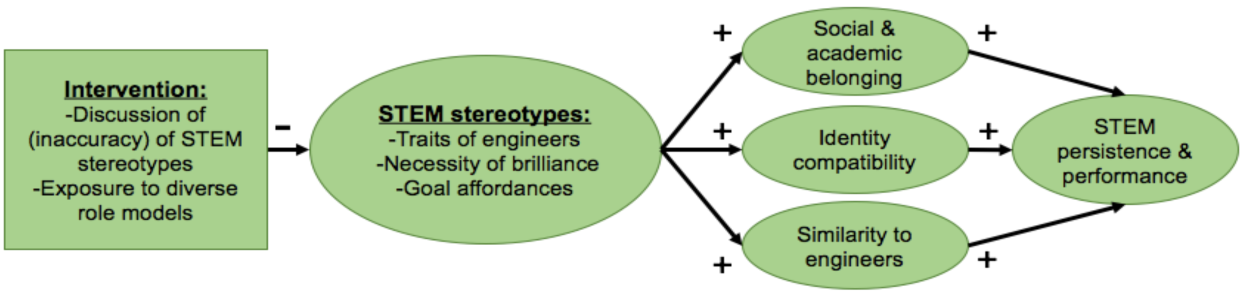

Figure 3. A path model representing key hypotheses.

Table 2. Questionnaire Measures.

Scale	**Sample Item**
Scientist Stereotypes	
Traits of engineers	What percentage of engineers are… e.g., intelligent, nerdy?
Necessity of brilliance	Being a top scholar of engineering requires an innate brilliance.
Goal affordances	A job in engineering enables you to help people.
Important Psychological Outcomes	
Social belonging	I feel like I fit in with people in my major.
Academic belonging	I feel similar to the kinds of people who have what it takes to succeed in my major.
Identity compatibility	I think my gender and my major are very compatible.
Similarity to engineers	People in engineering are a lot like me.
Intentions to persist	I could see myself going into a career related to my major.
Familiarity with Campaign	I am familiar with the #iLookLikeAnEngineer campaign.

1. The intervention will reduce STEM stereotypes for both women and men. First, trait stereotypes about engineers will become weaker and more positive. Specifically, a smaller percentage of engineers will be viewed as possessing negative stereotypic traits (e.g., nerdy, socially isolated), and a larger percentage will be judged as possessing positive counter-stereotypic traits (e.g., outgoing, friendly; Park, Judd, & Ryan, 1991). Second, the intervention will diminish the perception that engineering requires sheer brilliance (Leslie et al., 2015). Third, the intervention will increase the extent to which engineering is viewed as affording female-stereotypic communal goals (e.g., collaboration, helping mankind).
2. The reduction of engineering stereotypes will benefit all students, but especially women. The intervention should enhance both social belonging and ability belonging. Social belonging refers to the subjective experience of fitting in, being personally accepted, respected, and included as a member of a discipline (Good, Rattan, & Dweck, 2012); ability belonging refers to the sense that one has the intellectual skills required to succeed in the field (Lewis & Hodges, 2015). Women have lower scores than men on both in STEM fields (Banchefsky, Lewis & Ito, in preparation;

Walton & Cohen, 2007). Second, it will increase the compatibility of engineering with one's gender identity for women (Good et al., 2012; London et al., 2011). Finally, it will increase students' perceived similarity to the typical person in engineering. These factors are each established predictors of STEM persistence and performance (Dasgupta, 2011; Hannover & Kessels, 2004; Leslie et al., 2015, Walton & Cohen, 2007).

Assessment of outcomes. Sophisticated analytic techniques (e.g., structural equation modeling) will be used that can handle longitudinal data and missing data (due to attrition and incomplete responses). Analyses will address the hypotheses described above and illustrated in Figure 3. Moreover, interactions of each variable with participant gender will be assessed to address whether the intervention is especially beneficial for women. If sample sizes are adequate, student ethnicity and other demographics that are related to academic vulnerability (e.g., first-generation college student) will also be analyzed to see whether the intervention is especially beneficial for underrepresented groups.

Timeline

Summer 2016: Develop the questionnaire measures and submit all materials to the IRB for approval early in the summer. Gather initial reactions to the intervention from expert colleagues, as well as undergraduates participating in research. Conduct focus groups with STEM undergraduates. Fall 2016: Administer questionnaires and conduct intervention according to intervention timeline (Table 1). Manage datasets so they are ready for analysis. Spring 2017: Conduct data analyses. Present the results at DBER, within the Department of Psychology and Neuroscience, and other relevant conferences. Write up the results for publication. Use results to inform NSF and/or Spencer Foundation grant.

Outcomes & Impact of Proposed Project

The proposed research is expected to have several important benefits for researchers, STEM educators, students, and policy makers. First, it will further my professional development and support the education of a research assistant. The department of Psychology and Neuroscience and STEM departments should mutually benefit from collaborating to address diversity issues within STEM at CU-Boulder. In providing essential preliminary data, this research could also bring grant money to the Psychology & Neuroscience department. Most importantly, it is our hope that students in engineering, and the STEM community at CU-Boulder generally, will benefit from this project. The data and feedback from the proposed project will be used to hone the #iLookLikeAnEngineer intervention, which could be broadly administered across STEM courses. In addition, we could launch an advertising campaign featuring CU-Boulder STEM students with the hashtag. This campaign could be featured around campus, on CU-Boulder's website, and at local high schools in an effort to broaden perceptions of STEM, especially among people most likely to possess strong STEM stereotypes—those who have minimal exposure to students in STEM (Cheryan et al., 2013). I believe this research will inform and facilitate CU-Boulder's efforts to broaden participation in STEM. Thank you for the opportunity to apply for the Chancellor's Fellowship Award.

Budget & Justification

Description	**Cost**
Post-doc summer salary (2 summer months)	\$8,200
Focus group participant pay (\$15/hr x 20 participants)	\$300
Research Assistant (\$10/hr x 10 hrs/week x 15 weeks x 1 semester, Fall 2016)	\$1,500
Total	**\$10,000**

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