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Men's defense of their prototypicality undermines the success of women in STEM initiatives

Felix Danbold*, Yuen J. Huo

Department of Psychology, University of California, Los Angeles, 1285 Franz Hall, Los Angeles, CA 90095-1563, United States

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ABSTRACT

Two studies tested the prediction that men in STEM (Science, Technology, Engineering, & Math; students in Study 1; professionals in Study 2), who believed that initiatives to increase women's representation in these fields were effective would experience prototypicality threat (men's concern that they would no longer be the gender group that best represents what it means to be a member of the STEM community). Among those who believed it is legitimate for men to represent STEM, men's prototypicality threat mediated the relationship between perceptions that more women were entering their field and resistance toward this change (i.e., opposing women in STEM initiatives, wanting women to conform to the field's traditional norms, and expressing exclusionary intentions toward women peers). The opposite pattern was observed among those who rejected the idea that men's claim to represent STEM was legitimate. This work highlights how diversity initiatives in STEM, if successful, can be undermined by triggering prototypicality threat among men.

Significant resources are invested in initiatives to increase diversity within a wide range of professional fields. One such effort is work addressing the underrepresentation of women in STEM (Science, Technology, Engineering, and Math). As this persistent underrepresentation is driven primarily by women leaving STEM, people often invoke a “leaky pipeline” metaphor to characterize the challenge of increasing gender diversity in this domain (Fouad & Singh, 2011; Pawley & Hoegh, 2011; Xu, 2008). Accordingly, most relevant research has focused on understanding how women experience challenges associated with entering and persisting in STEM (e.g., Good, Rattan, & Dweck, 2012; Murphy, Steele, & Gross, 2007; Smith, Lewis, Hawthorne, & Hodges, 2013). Often overlooked, however, is the role men play in creating and enforcing these challenges (Blickenstaff, 2005). As gender diversity initiatives could, if successful, one day make women the majority group in STEM, this research seeks to understand whether or not men will embrace or undermine this change.

1. The cost to men of gender diversity: losing the claim to best represent STEM

Given a growing embrace of diversity as good for both society and industry (Bell & Hartmann, 2007; Herring, 2009) and institutional arguments that women are necessary to meet growing employment demands in STEM (Olson & Riordan, 2012), men may welcome efforts to increase gender diversity in STEM. However, other evidence suggests that women face structural challenges in STEM that men do not (Ceci & Williams, 2010; Moss-Racusin, Dovidio, Brescoll, Graham, & Handelsman, 2012) and that men reinforce existing gender inequality by denying the existence of these challenges (Handley, Brown, Moss-Racusin, & Smith, 2015). Therefore, it is equally, if not more, likely that rather than responding positively, men will respond negatively to the prospect of more women entering these fields. Thus, men may support women in STEM initiatives in theory, but not in practice. We suggest here, that there is a potentially overlooked driver of this opposition, men's fear of losing their standing as the prototypical subgroup in STEM – the valued exemplar against which women in STEM are expected to conform.

1.1. *The value of being the prototypical subgroup*

The insight that men may resist the entry of women into STEM because this would challenge their standing as the prototypical subgroup in the field is rooted in work on group norms. Specifically, self-categorization theory argues that group prototypes serve as the norm against which individual members are judged, with those most prototypical evaluated most positively (Oakes, Haslam, & Turner, 1998; Turner, 1987). Extending this insight from *within*-group processes into the context of *inter*group relations, the ingroup projection model (Wenzel, Mummendey, & Waldzus, 2007) articulated that just as individuals differ in the degree to which they represent group norms,

* Corresponding author.
E-mail addresses: fdanbold@ucla.edu (F. Danbold), huo@psych.ucla.edu (Y.J. Huo).

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subgroups (e.g., ethnic groups, gender groups, etc.) differ in the extent to which they represent their broader superordinate categories (e.g. nations, professions, etc.). The ingroup projection model further predicts that within valued superordinate categories people are inclined to maximize the extent to which they see their subgroup as prototypical (Machunsky & Meiser, 2014; Mummendey & Wenzel, 1999). After all, belonging to the prototypical subgroup confers certain benefits, such as exemption from a tension between one's subgroup norms and those of the superordinate category. The potential loss of these benefits is what makes challenges to subgroup prototypicality threatening.

The key phenomenon at hand then, is prototypicality threat, or the concern that one's claim to prototypicality may be lost. Prior research on threats to prototypicality has largely examined this experience in the *intra*group setting, focusing on individuals' standing within their ingroup (Branscombe, Ellemers, Spears, & Doosje, 1999; Hunt, Gonsalkorale, & Murray, 2013; Maass, Cadinu, Guarnieri, & Grasselli, 2003; Schmitt & Branscombe, 2001). Typically, these studies induced prototypicality threats by informing individuals that they were not representative of their ingroup (e.g., informing men that they are low in masculinity). Here we extend this work into the domain of *inter*group relations, and examine concerns about the loss of subgroup prototypicality (e.g., how changes in gender demographics threaten men's belief about their gender group's claim to best represent STEM).

One interesting result of this shift to the intergroup domain is that due to the structural realities of group-based hierarchies, it is generally the dominant subgroup in a given social category (e.g., the largest numerical group and the one that holds the majority share of power and resources) that is viewed as the prototype against which members of all other subgroups are evaluated (Alexandre, Waldzus, & Wenzel, 2016; Waldzus, Mummendey, Wenzel, & Boettcher, 2004). Members of non-dominant subgroups, in contrast, have little claim to prototypicality, and thus cannot experience concern about losing it. This makes prototypicality threat at the group level a phenomenon specific to the dominant subgroup. Therefore, for this paper we focus on *prototypicality threat* as the concern among members of the dominant subgroup that their standing as the prototypical subgroup will be lost.

1.2. Men are the prototypical subgroup in STEM

There is substantial evidence that, although their numbers vary across disciplines, men are the dominant subgroup that lays claim to representing STEM as a whole. For example, when asked to draw a scientist, both children and adults typically portray men (Chambers, 1983; Mead & Metraux, 1957). Similarly, environments in STEM are generally shaped by and reflect the particular norms and culture of the men-majority in those fields (Cheryan, Master, & Meltzoff, 2015; Cheryan, Plaut, Davies, & Steele, 2009). As prototypicality concerns increase during times of social change (Rosa & Waldzus, 2012), men in the modern STEM environment, where gender diversity efforts are commonplace, are likely to be particularly vigilant to cues of prototypicality threat. This logic leads us to propose that men in STEM who see gender diversity initiatives as succeeding in bringing women into the field in unprecedented numbers will experience prototypicality threat. This experience of prototypicality threat will then motivate men to challenge both initiatives to bring more women into STEM (i.e., the source of their threat) and these policies' beneficiaries (i.e., women).

2. Individual differences in susceptibility to prototypicality threat

When confronted with information signaling the potential loss of their prototypicality in STEM, some men may experience prototypicality threat more strongly than others. For example, prior research has shown that although White Americans as a subgroup are generally viewed as prototypical of the broader superordinate category of all Americans, there are notable individual differences in the extent to which Whites report seeing themselves as such (Danbold & Huo, 2015). In this work, the more Whites viewed their ethnic group as better representing America than other ethnic groups, the more they experienced prototypicality threat in response to information about the rapid growth of non-Whites in the U.S.

Here, we extend this earlier finding by examining whether a new individual difference moderator, belief among members of the dominant subgroup that their standing as the prototype of the superordinate category is legitimate, would shape men's reactions to the entry of women into STEM. This new moderator, *prototypicality legitimacy*, refers to the endorsement of the belief that it is valid and right for one's subgroup to represent and define the superordinate category (i.e., that men *should* be prototypical in STEM). Several factors may feed into the endorsement of prototypicality legitimacy beliefs including a subgroup's historical dominance and/or numerical majority status. Most prevalent in STEM however, are biological explanations of gender differences (e.g., that men are innately superior in STEM) that justify men's prototypicality in these fields (Ceci, Williams, & Barnett, 2009; Halpern et al., 2007).

Beliefs that men's prototypicality in STEM is legitimate are widespread. From early age through adulthood, both men and women endorse the belief that men are more naturally gifted in STEM than women (Räty, Vänskä, Kasanen, & Kärkkäinen, 2002). Although some gender differences in mathematical and spatial ability have been observed, the belief that men are inherently more adept in STEM appears to be primarily a social construct (Ceci & Williams, 2010; Leslie, Cimpian, Meyer, & Freeland, 2015; Ortner & Sieverding, 2008), and as such is likely to vary across individuals. Therefore, while we expected that men would experience prototypicality threat when informed that a rapidly growing number of women in STEM might threaten their majority status and therefore their prototypicality, this threat should be strongest among those high in prototypicality legitimacy beliefs.

3. Responses to prototypicality threat

As it is psychologically valuable to perceive one's subgroup as prototypical, those under prototypicality threat should be motivated to defend against this threat. Two key responses to prototypicality threat are theorized and supported by past research (Danbold & Huo, 2015) – the desire to reassert the prototypicality of one's subgroup and the desire to oppose the source of threat. Members of the dominant subgroup under prototypicality threat may try to reassert their claim to represent the superordinate category by demanding that, in spite of social change, members of other subgroups should continue to conform to their norms. In the STEM context, men who experience prototypicality threat are then likely to demand that women conform to men's existing norms in the field. Additionally, members of the dominant group who experience prototypical threat may also attempt to stop or slow the source of the threat. In the STEM context, we predict that resistance to women entering STEM will be expressed in two ways. First, threatened men may express opposition to initiatives aimed at increasing the representation of women in STEM. Second, they may also express the intention to act in exclusionary ways toward women entering STEM. Through both of these actions, men can potentially curtail the number of women in STEM, thus alleviating their feelings of prototypicality threat.

4. Present research

Two studies[1] tested the prediction that at different stages of the STEM "pipeline" (among undergraduate STEM majors in Study 1 and STEM professionals in Study 2), men who believe that their gender's claim to represent STEM is legitimate would experience prototypicality

[1] We report all measures, manipulations, and exclusions in these studies.

threat when exposed to information that diversity initiatives are successfully bringing more women into STEM. In turn, we predicted that prototypicality threat would motivate men to defend their claim to best represent STEM, expressed in the desire for women to conform to traditional STEM culture, opposition to women in STEM initiatives, and exclusionary intentions toward women peers. These predictions suggest that successful women in STEM initiatives may backfire by triggering exclusionary behaviors among men, fueled by perceived threats to their claim to be the prototypical gender group against which all subgroups in STEM should be evaluated.

5. Study 1 – do successful women in STEM initiatives trigger prototypicality threat among undergraduate men?

5.1. Method

5.1.1. Experimental design

Undergraduate men majoring in STEM were randomly assigned to one of two conditions in which they read an article reporting that an initiative at their university was either *succeeding* or *failing* to increase the representation of women in STEM majors at their university.

5.1.2. Participants

One hundred and ninety-one male undergraduate students at a large west coast public university participated. A target sample size of 100 participants was based upon past research experimentally inducing threat among members of the dominant group (Craig & Richeson, 2014; Danbold & Huo, 2015). To accommodate for the proposed test of moderated mediation and to account for anticipated exclusion criteria (e.g., ineligible participants, violations of study protocol) once our target had been reached, we extended our data collection stop point until the end of the academic year. No data was examined or analyzed before this stop point. The average age was 21.43 years. Political views were assessed from "extremely liberal" (1) to "extremely conservative" (7), 56.9% placed themselves on the liberal side of the scale, 26.1% at the midpoint, and 17.0% on the conservative side of the spectrum. Because the stimuli involved reactions to demographic changes in STEM undergraduate programs at the university, students who were not undergraduates ($n = 17$) were removed from subsequent analyses. International students ($n = 28$) were also excluded to reduce error associated with possible language barriers and the introduction of cultural variance in gender norms. Four participants who violated research protocol (e.g., looking at another nearby participants' study materials) were also excluded, resulting in a final sample of 145 participants.

5.1.3. Procedure

Trained research assistants approached individuals in the area of campus where STEM major classes are commonly held and asked them what their major was. Only men who self-identified as STEM majors (e.g., Biology, Engineering, Computer Science, etc.) were invited to participate. All those who completed the study were entered into a lottery to win one $100 prize.

Across both articles, participants read about what was presented as the "Women in STEM Initiative (WSI)," aimed at increasing the representation of women in STEM majors on campus (available in Supplementary online materials). In the "majority loss" condition, participants were told that this initiative was successful and saw a graph and accompanying text showing that as a result, women are projected to meet or even surpass men as a percentage of science and engineering majors at the university within the next five years. In contrast, participants in the "majority retention" condition were told that the WSI was not expected to lead to a dramatic change in the gender demographics of STEM at the university, and that men would retain their majority status over the coming five years.

To ensure that neither condition seemed especially unusual to participants, and to add to our cover story that we were interested in students' reactions to a recent article from the university's newspaper, after reading the article participants were asked to indicate the extent to which they felt it was interesting and relevant to them, their familiarity with the WSI and whether or not they had read similar articles in the past. There were no significant differences between conditions on perceived interest, relevance, familiarity with the WSI, or experience with similar articles (all $ps > 0.050$). Participants then completed items assessing the main outcome variables: prototypicality threat, opposition to women in STEM initiatives, and desire for women to conform to masculine norms in STEM. This was followed by a measure of our moderator, prototypicality legitimacy. Finally, participants completed demographic items and were thanked and debriefed by the research assistant.

5.1.4. Measures[2]

Prototypicality threat and assimilation items were adapted from items previously used in the context of Whites' reactions to demographic changes in the U.S. (Danbold & Huo, 2015). All other items were developed specifically for this study.

5.1.4.1. Prototypicality threat

Two items assessed the extent to which men felt that their prototypicality in STEM would be threatened in the future: "I'm concerned that in the future, men will no longer best represent my major.", and "I worry that in the future it won't be clear what it means to be a member of my major." (1 = *strongly disagree* to 7 = *strongly agree*; $r = 0.33$, $p < 0.001$).

5.1.4.2. Desire for women to conform to dominant STEM norms

Two items measured participants' endorsement of the assimilation of women to men in STEM: "If women want to do well in my major, they should copy what men do in my major.", and "Women in my major should adapt to the values and practices of men in my major." (1 = *strongly disagree* to 7 = *strongly agree*; $r = 0.72$, $p < 0.001$).

5.1.4.3. Opposition to women in STEM initiatives

Three items assessed participants' opposition to the Women in STEM Initiative (WSI), described identically for all participants as aiming to increase the representation of women in STEM: "I think efforts like the Women in STEM Initiative are a poor use of resources.", "I think the Women in STEM Initiative is a good thing." (reverse coded), and "If the Women in STEM Initiative were up for a vote, I would vote in support of it." (reverse coded) (1 = *strongly disagree* to 7 = *strongly agree*; $\alpha = 0.88$).

5.1.4.4. Prototypicality legitimacy

Two items assessed perceptions of the legitimacy of men's prototypicality in STEM: "Men are naturally better at my major than women", and "There's good reason why men are the majority in my major." (1 = *strongly disagree* to 7 = *strongly agree*; $r = 0.57$, $p < 0.001$). Although these items were asked after, rather than prior to the manipulation, there was no effect of the manipulation ($p = 0.966$) suggesting that prototypical legitimacy is a stable attitude.

[2] As is common practice in our field, our post-experimental questionnaire included additional exploratory measures intended to aid in the development of future studies. These measures were neither central to the study's predictions nor tested in the study's analyses. These included measures of past experience with women in STEM, degree of identification with STEM and man identities, attitudes toward women in STEM, concerns about jobs in the STEM field, estimates of current and desired representation of women in STEM, beliefs about dating prospects, single items of hostile and benevolent sexism, and thoughts on the survey. Also collected were demographic items measuring year in school, major, gender identity, sexual orientation, and ethnicity.

Table 1
Study 1 descriptives and correlations.

	M	SD	Prototypicality legitimacy	Prototypicality threat	Desire for women to conform	WSI opposition
Prototypicality legitimacy	2.35	1.28				
Prototypicality threat	2.20	1.10	0.26**			
Desire for women to conform	2.46	1.19	0.56**	0.20*		
WSI opposition	2.56	1.20	0.42**	0.23**	0.39**	

Note. M = mean. SD = standard deviation. WSI = women in STEM initiatives. * $p < 0.05$. ** $p < 0.01$.

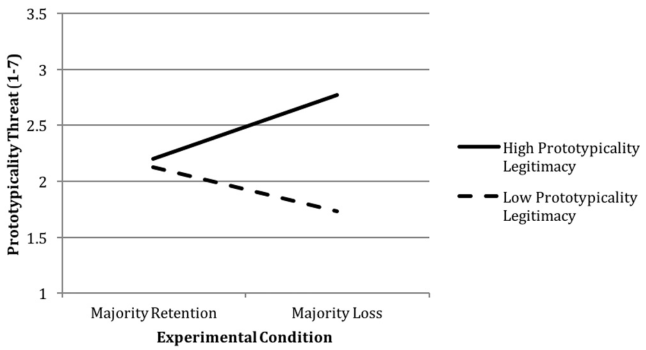

Fig. 1. Study 1 interaction of condition by prototypicality legitimacy on prototypicality threat. High and low values of prototypicality legitimacy are + 1 SD and − 1 SD from the mean.

5.2. Results

All the following analyses use mean scores of the scales described above. Descriptives and inter-item correlations are shown in Table 1. Given relatively low scale means, we checked our data for outliers found none.

5.2.1. Prototypicality legitimacy as a moderator

We used multiple regression to test the prediction that successful women in STEM initiatives would increase reports of prototypicality threat, especially among those who believed that it is legitimate for men to be prototypical in STEM. There was no significant main effect of condition on prototypicality threat (β = 0.09, 95% CI = [− 0.25–0.43], standardized Beta = 0.04, $p = 0.611$), nor was there a significant main effect of prototypicality legitimacy (β = 0.04, 95% CI = [− 0.21–0.28], standardized Beta = 0.03, $p = 0.765$). More importantly, as predicted, there was a significant interaction between our manipulation and prototypicality legitimacy (β = 0.48, 95% CI = [0.14–0.83], standardized Beta = 0.32, $p < 0.01$, $\Delta R^2 = 0.05$, $p = 0.006$). As seen in Fig. 1, for participants high in prototypicality legitimacy, being exposed to information about the loss of men's majority status in STEM resulted in higher levels of prototypicality threat. Simple slopes analysis revealed a significant positive slope for individuals relatively high (+ 1 SD) in prototypicality legitimacy (gradient = 0.57, $p = 0.021$). For participants who were low (− 1 SD) in expressing agreement with men's prototypicality legitimacy in STEM, an opposite pattern was observed. Learning that men's share of the field would be shrinking was associated with less prototypicality threat than when they were told men in STEM would retain their majority status. However, in simple slopes analysis, this effect was not significant (gradient = − 0.39, $p = 0.110$).

5.2.2. Moderated mediation

Next, we conducted moderated mediation to test whether the indirect effect of our manipulation of men's numerical representation in STEM on desire for women to conform and opposition to women in STEM initiatives through prototypicality threat, was moderated by prototypicality legitimacy.[3] This was tested using Hayes' PROCESS Macro (Hayes, 2013) Model 7 (Fig. 2).

Table 2 shows the conditional indirect effect of our men in STEM majority loss manipulation on desire for women to conform and opposition to the Women in STEM Initiative through prototypicality threat at conditional levels of prototypicality legitimacy using 50,000 bootstrapped resamples.

The indirect effect of our manipulation on desire for women to conform through prototypicality threat was not reliable for participants who were at the mean in prototypicality legitimacy (prototypicality legitimacy = 2.35, roughly "disagree" on our 1–7 scale), IE = 0.02; bias-corrected 95% Confidence Interval = [− 0.05, 0.13]. For those one standard deviation above the mean (prototypicality legitimacy = 3.63, under half a scale point below "neither agree nor disagree"), there was a reliable and positive indirect effect, IE = 0.13; BC 95% CI = [0.02, 0.33]. This pattern reversed, and there was a negative indirect effect for individuals who were one standard deviation below the midpoint (prototypicality legitimacy = 1.06, roughly "strongly disagree"); IE = − 0.09, BC 95% CI = [− 0.27, 0.00]. Although this indirect effect (for men low in prototypicality legitimacy) was not significant (the confidence interval here does contain zero), the upper limit of the confidence interval indicated this effect approached significance (ULCI = 0.0007).

When evaluating our predictions on men's opposition to women in STEM initiatives, we found similar patterns of effects. As before, there was no reliable indirect effect for participants at the mean (prototypicality legitimacy = 2.35), IE = 0.02; BC 95% CI = [− 0.06, 0.13], but there was a significant positive indirect effect for participants one standard deviation above the mean (prototypicality legitimacy = 3.63), IE = 0.14, BC 95% CI = [0.03, 0.34]. This pattern again was reversed such that there was a negative indirect effect for participants one standard deviation below the mean (prototypicality legitimacy = 1.06), IE = − 0.10; BC 95% CI = [− 0.28, 0.00]. Again, although the indirect effect for men low in prototypicality legitimacy was not significant (the confidence interval here also contains zero), the upper limit of the confidence interval indicated this effect approached significance (ULCI = 0.0004).

5.3. Discussion

As predicted, when men who believed that their prototypicality in STEM was legitimate were told that an initiative to increase the representation of women in STEM was successful (compared to failing), they experienced greater levels of prototypicality threat. This threat led to increased demands for women to conform to men's norms and

[3] As it was not necessary to demonstrate evidence of mediation (Rucker, Preacher, Tormala, & Petty, 2011), we made no a priori predictions about the effect of our manipulation and prototypicality legitimacy on our outcome variables. Post hoc analyses, however, revealed patterns of results that mirrored the effect shown in Fig. 1 (i.e., men highest in prototypicality legitimacy who saw that their majority would be lost showed the highest scores on these measures). The interaction between our manipulation and prototypicality legitimacy on desire for women to conform was statistically significant ($p = 0.017$) and the interaction between our manipulation and prototypicality legitimacy on opposition to women in STEM initiatives was marginally significant ($p = 0.082$).

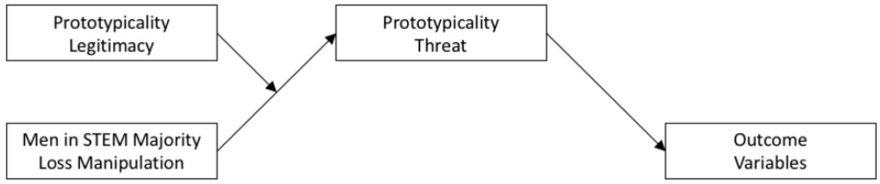

Fig. 2. Study 1 and Study 2 moderated mediation. Men in STEM majority loss manipulation is coded such that 0 = Men's Majority Retention condition, 1 = Men's Majority Loss condition. Study 1 outcome variables are Desire for Women to Conform and Opposition to Women in STEM Initiatives. Study 2 outcome variables are Desire for Women to Conform, Opposition to Women in STEM Initiatives, and Exclusionary Intentions Toward Women.

Table 2
Study 1 conditional indirect effect of perceived men in STEM majors majority loss on desire for women to conform and opposition to women in STEM initiatives through prototypicality threat at low (− 1 SD), moderate (Mean), and high (+ 1 SD) levels of prototypicality legitimacy.

Conditional level of prototypicality legitimacy	Indirect effect	Bootstrapped standard error	Bias-corrected lower limit	Bias-corrected upper limit
OUTCOME = desire for women to conform				
− 1 SD (1.06)	− 0.09	0.06	− 0.27	0.00
Mean (2.35)	0.02	0.04	− 0.05	0.13
+ 1 SD (3.63)	**0.13**	**0.08**	**0.02**	**0.33**
OUTCOME = opposition to women in STEM initiatives				
− 1 SD (1.06)	− 0.10	0.07	− 0.28	0.00
Mean (2.35)	0.02	0.05	− 0.06	0.13
+ 1 SD (3.63)	**0.14**	**0.08**	**0.03**	**0.34**

Note. SD = standard deviation. Bias-corrected 95% confidence intervals were calculated using 50,000 bootstrap samples (with replacement). Significant conditional indirect effects ($p < 0.05$) are highlighted in boldface.

increased opposition to the initiative they saw.

An unexpected finding from this study was the pattern that men low in prototypicality legitimacy (i.e., those who strongly rejected the notion that men should be prototypical in STEM) reported lower levels of prototypicality threat when they thought women in STEM initiatives were successful than when these initiatives were stalling. This suggests that men low in prototypicality legitimacy, relative to those who are high, may be more willing to embrace the prospect of more women entering their professional domains. Although this pattern of finding suggested a silver lining by highlighting a group of men who may serve as allies (Drury & Kaiser, 2014) in the effort to create greater gender diversity in STEM, this pattern did not reach conventional thresholds of significance. In Study 2, we examined whether this unexpected pattern of finding among men low in prototypical legitimacy beliefs would replicate.

A key limitation of this study is the focus on undergraduate men. Because women are entering STEM majors at much higher rates than they are STEM professions (National Science Foundation, 2012), undergraduate men may already be vigilant to the effects of demographic change, and therefore more likely to experience prototypicality threat. In Study 2, we sought to provide a harder test of our predictions by looking down the pipeline to examine whether Study 1 findings could be replicated among men employed in STEM, where men's prototypicality is currently more secure. Study 2 also added a new outcome measure of exclusionary behavioral intentions toward women in STEM. Finally, we included an individual difference measure of masculinity insecurity (i.e., men's concern about not being able to meet traditional gender roles; Eisler & Skidmore, 1987). We included this in our models to see if our predicted pattern of results held over and above more general insecurity about their masculinity across domains.

6. Study 2 – looking down the pipeline - do successful women in STEM initiatives trigger prototypicality threat among men professionals?

6.1. Method

6.1.1. Experimental design

Men professionals working in STEM fields were randomly assigned to one of two conditions in which they read an article reporting that federal initiatives to increase representation of women in STEM careers were either *succeeding* or *failing* to increase the representation of women in STEM careers in the U.S.

6.1.2. Participants

One hundred and fifty-five professional men working in STEM fields were recruited from Amazon Mechanical Turk to participate in a study titled, “Changes in Your Profession” and were paid $1.00. As in Study 1, we drew upon previous research (Craig & Richeson, 2014; Danbold & Huo, 2015) to set a target sample size of 100 and increased this to 150 to account for anticipated exclusion criteria (e.g., failure of manipulation checks). We posted this total number of HITs to Mechanical Turk and stopped data collection when all had been completed. Average age was 32.61 years. Political views were assessed on 7-point scale from “extremely liberal” (1) to “extremely conservative” (7): 56.1% placed themselves on the liberal side of the scale, 23.0% at the midpoint, and 21.0% on the conservative side. Participants were asked to self-identify their professional field.

6.1.3. Procedure

Potential participants completed a brief eligibility survey. Only men who said that they were full-time or part-time employed in a STEM field (defined as teaching or conducting research in science, technology, engineering, or math) were recruited into the study. Thirty-two participants whose self-described professional fields were not clearly in STEM (e.g., military, business management, non-specific education, etc.) were removed from subsequent analyses.

To ensure no effect of our manipulation on our predicted moderator, participants first responded to questions assessing prototypicality legitimacy, operationalized as the extent to which they believed men to be inherently better at STEM than women. Participants were then randomly assigned to read one of two articles (available in Supplementary online materials) about the outcome of a federal STEM initiative on diversifying the gender distribution of professionals in STEM fields. Across conditions, participants were told they would be reading an excerpt from an ostensibly real newspaper article which indicated that 2014 marked the eighth anniversary of the National Science Foundation's Women in STEM Initiative (WSI) designed to increase the number of women in STEM careers in the U.S. The information in the two conditions then diverged on whether the program was succeeding or failing. In the “majority loss” condition, participants were told that the WSI was successful and that the percentage of women in STEM would be “reaching, and perhaps surpassing equal representation with men around 2050." In the "majority retention" condition, participants were told that the WSI had resulted in "no significant increase in the percentage of women" in STEM and that women would remain a "far smaller percentage than men through 2050." The timescale of the predicted demographic change was extended here from the timescale used for the undergraduate student sample in Study 1. For undergraduates who are enrolled in their program for typically four years, we set a relatively short timeframe for demographic change to ensure that the predicted changes would be relevant to our participants. For professionals, a longer timeframe is more realistic for significant changes in gender distribution in STEM to take place. In addition, because slower changes are less threatening than rapid ones, the longer time frame used in Study 2 also served as a stronger test of our theory. Participants next completed a stimuli recall check, followed by items measuring prototypicality threat and the dependent variables (desire for women to conform to men in STEM, opposition to women in STEM initiatives, and exclusionary intentions toward women peers), and an individual difference measure of masculinity insecurity. Finally, participants completed a manipulation check and demographics items, and were debriefed and thanked.

6.1.4. *Measures*[4]

As in Study 1, prototypicality threat and assimilation items were adapted from measures described in Danbold & Huo, 2015. In addition, masculinity insecurity was measured with items from an existing scale (Eisler & Skidmore, 1987). All other measures were developed for the purpose of this study.

6.1.4.1. *Prototypicality threat*

Three items assessed the extent to which participants felt that their prototypicality in STEM would be threatened in the future: "I worry that by 2050, it won't be clear what my professional field stands for.", "I am concerned that by 2050, men will no longer represent my field's professional identity.", and "I believe there will always be a place for men like me in my professional field." (reverse coded) (1 = *strongly disagree* to 7 = *strongly agree*; α = 0.73).

6.1.4.2. *Desire for women to conform to dominant STEM norms*

Five items measured participant's endorsement that women should conform to the norms set by men in STEM: "If women want to do well in my professional field, they should adopt the values and practices of men.", "Women could learn a lot from men in my professional field.", "My professional field would be stronger if women conformed to the standards set by men.", "My professional field would be more respected if women conformed to standards set by men.", and "That men and women both contribute is a strength of my professional field." (reverse coded) (1 = *strongly disagree* to 7 = *strongly agree*; α = 0.84).

6.1.4.3. *Opposition to women in STEM initiatives*

Three items assessed participants' opposition to the Women in STEM Initiative (WSI), described as aiming to increase the representation of women in STEM: "I oppose this initiative.", "I think it's a good idea to increase the percentage of women in my professional field to at least 50%." (reverse coded), and "If this initiative were up for a vote, I would vote in support of it." (reverse coded) (1 = *strongly disagree* to 7 = *strongly agree*; α = 0.82).

6.1.4.4. *Exclusionary intentions toward women in STEM*

Five items measured participants' intention to behave in an exclusionary way toward women STEM professionals: "It is not my responsibility to make women feel included in my professional field.", "It is unlikely that most women could ever feel like they belong in my professional field.", "Women need thick skin to feel at home in my professional field.", "I go out of my way to make women in my professional field feel welcome." (reverse coded), and "I like to ensure that all individuals feel welcome in my professional field regardless of gender." (reverse coded) (1 = *strongly disagree* to 7 = *strongly agree*; α = 0.63). Higher scores indicate more exclusionary behavioral intentions.

6.1.4.5. *Prototypicality legitimacy*

In contrast to Study 1, in Study 2, prototypicality legitimacy measures were developed to more directly and explicitly tap into the idea that men are more innately capable in STEM than women. Three items, measured prior to the manipulation, assessed the extent to which participants felt that innate ability legitimized their group's prototypicality in STEM: "There is something innate about being a man that makes someone better at working in my professional field.", "There is a biological basis for why men do better at my professional field than women.", and "Biology has nothing to do with men or women succeeding in my professional field." (reverse coded) (1 = *strongly disagree* to 7 = *strongly agree*; α = 0.81).

6.1.4.6. *Masculinity insecurity*

A subset of items from the 40-item Masculine Gender Role Stress Inventory (Eisler & Skidmore, 1987) were assessed to examine whether or not the pattern of results observed in Study 1 would hold over and above men's general sense of insecurity around their individual masculinity across domains. Fourteen items were drawn from the three most theoretically relevant subscales: subordination to women, intellectual inferiority, and performance failure, and measured the degree of perceived stress (1 = *not at all stressful*, 7 = *extremely stressful*) elicited by situations such as "Being outperformed at work by a woman.", "Talking with a 'feminist'", and "Being unemployed" (α = 0.85).

6.1.4.7. *Stimuli recall and manipulation check*

A stimuli recall check followed the display of the experimental manipulations to ensure that participants understood the intention of the initiative they read about: "Recall the initiative you just read about. Did that initiative aim to make the percentage of women in STEM increase, decrease, or stay the same?"

To evaluate the effectiveness of our manipulation participants were asked to respond to two manipulation check items. The first item asked "Relative to today, to what extent do you think the percentage of women in STEM will increase, decrease, or stay the same?" (1 = *decrease dramatically* to 7 = *increase dramatically*). The second asked, "To what extent did you believe that the initiative would successfully do what it intended to do?" (1 = *not at all* to 7 = *extremely*).

6.1.4.8. *Additional checks*

Finally, participants responded to two additional measures which were intended to ensure that our two conditions were perceived by participants as comparable on important dimensions that are unrelated to the manipulation: that the STEM Initiative regardless of its effectiveness was perceived as a good idea and that the information presented in the two articles were considered equally valid. We asked participants, "To what extent did you believe that the initiative is a good idea?" (1 = *not at all* to 7 = *extremely*), and "To what extent do you believe that the findings from the article you read were valid?" (1 = *not at all* to 7 = *extremely*).

[4] Similar to Study 1, exploratory measures not central to our main research questions or analyses were collected. These included perceived ingroup prototypicality, realistic and symbolic threat, measures of support for women in STEM initiatives to a point, affirmative action support, beliefs about dating prospects, identification with professional field, ambivalent sexism, sexism stereotype threat, and social dominance orientation. Demographic measures of specific professional field, ethnicity, self and parents' countries of origin, level of education, duration at current profession, income, political party identification, relationship status, sexual orientation, and gender identity were also collected.

Table 3
Study 2 descriptives and correlations*.

	M	SD	Prototypicality legitimacy	Prototypicality threat	Desire for women to conform	WSI opposition	Exclusionary intentions toward women	Masculinity insecurity
Prototypicality legitimacy	2.92	1.45	–					
Prototypicality threat	2.21	1.05	0.39**	–				
Desire for women to conform	3.37	1.21	0.63**	0.40**	–			
WSI opposition	2.83	1.35	0.44**	0.32**	0.51**	–		
Exclusionary intentions toward women	3.16	0.99	0.47**	0.42**	0.62**	0.49**	–	
Masculinity insecurity	3.50	0.94	0.47**	0.31**	0.44**	0.38**	0.37**	–

Note. M = mean. SD = standard deviation. WSI = women in STEM initiatives. * $p < 0.05$. ** $p < 0.01$.

6.2. Results

All the following analyses use mean scores of the scales described above. Descriptives and inter-item correlations are shown in Table 3. Given relatively low scale means, we checked our data for outliers found none.

6.2.1. Stimuli recall and manipulation check

Twelve participants across conditions did not correctly recall that the WSI aimed to increase the percentage of women in STEM and were dropped from subsequent analyses. Four additional participants who did not complete the outcome measures were dropped from analyses, leaving a final sample size of 107 participants.

Participants in the majority loss condition reported significantly higher expectations that the percentage of women in STEM would increase ($M = 5.45$, $SD = 0.81$) than participants in the majority retention condition ($M = 5.02$, $SD = 0.67$), $F(1, 105) = 9.13$, $p = 0.003$. Participants in the majority loss condition were also significantly more likely to report that the Women in STEM Initiative was successful ($M = 4.43$, $SD = 1.32$) than did participants in the majority retention condition ($M = 3.74$, $SD = 1.38$), $F(1, 104) = 6.90$, $p = 0.010$.

6.2.2. Additional checks

There was no significant difference regarding perceptions about the extent to which the WSI was a good idea between the majority loss condition ($M = 4.76$, $SD = 1.62$) and the majority retention condition ($M = 5.07$, $SD = 1.57$), $F(1, 104) = 0.99$, $p = 0.323$. There was also no significant difference in the perceived validity of the findings presented in the article between participants in the majority loss condition ($M = 4.25$, $SD = 1.48$) and the majority retention condition ($M = 4.50$, $SD = 1.46$), $F(1, 103) = 0.73$, $p = 0.395$, indicating that participants perceived the information in both conditions to be equally believable. These patterns of findings provide assurance that any mean differences we observe in our dependent variables can be attributed to the experimental manipulation and not to differences in global evaluations of the initiatives or the validity of the information presented in the article.

6.2.3. Prototypicality legitimacy as moderator

Using multiple regression, we tested the prediction that, consistent with Study 1, men led to believe that the WSI would be successful in bringing more women into the field would experience greater prototypicality threat, but only among those who are high in prototypicality legitimacy beliefs (i.e., the belief that men are naturally better suited to STEM than women). We did so controlling for masculinity insecurity (although patterns of result are consistent with or without the inclusion of this covariate[5]). There was no significant main effect of condition (β = 0.06, 95% CI = [−0.30–0.42], standardized Beta = 0.03, $p = 0.744$), nor was there a significant main effect of prototypicality legitimacy on prototypicality threat (β = 0.10, 95% CI = [−0.14–0.36], standardized Beta = 0.10, $p = 0.416$). Consistent with predictions, there was a significant interaction between our experimental manipulation and prototypicality legitimacy (β = 0.56, 95% CI = [0.20–0.93], standardized Beta = 0.35, $p = 0.003$).[6] As seen in Fig. 3, for participants high in prototypicality legitimacy, being told about the pending loss of men's majority status in STEM produced higher levels of prototypicality threat. Similar to Study 1, the opposite pattern was found for men low in prototypicality legitimacy. For these participants low in prototypicality legitimacy, who believed there was no legitimate reason why men are proto-

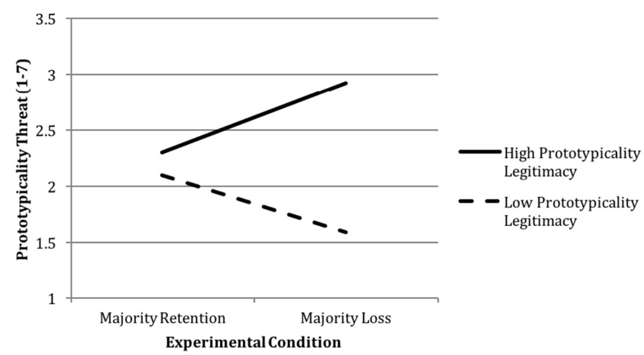

Fig. 3. Study 2 interaction of condition by prototypicality legitimacy on prototypicality threat. High and low values of prototypicality legitimacy are +1SD and −1SD from the mean.

[5] Without the inclusion of masculinity insecurity as a covariate, there was again no significant main effect of condition (β = 0.05, $p = 0.776$), no significant main effect of prototypicality legitimacy on prototypicality threat (β = 0.15, $p = 0.213$), and a significant interaction between our experimental manipulation and prototypicality legitimacy (β = 0.59, $p = 0.002$).

[6] To lay the foundation for future studies, we collected measures of realistic threat (e.g., concern that in the future "women will have made it more difficult for men to get jobs in my professional field") and symbolic threat (e.g., concern that in the future "the values and beliefs of women regarding work will not be compatible with the values and beliefs of men in my professional field."; both adapted from Stephan, Ybarra, & Bachman, 1999). These measures were being piloted tested and were not part of the a priori predictions for Study 2. In post hoc analyses, with these threats included in the model shown in Fig. 3, the general pattern of results held, but the interaction between our manipulation and prototypicality legitimacy on prototypicality threat dropped to marginal significance. Although we are hesitant to interpret significance values in exploratory analyses, the weakening of this effect may owe to the fact that, despite clear conceptual distinctions between these forms of threat, disentangling them empirically has been a persistent challenge in the literature (e.g., Riek et al., 2006). Our goal in future work is to develop more precise measures of other forms of group-threat that can be more clearly empirically distinguished from prototypicality threat.

typical in STEM, being told about the pending loss of men's majority status in STEM led to lower levels of prototypicality threat. Simple slopes analyses revealed a significant positive slope for individuals high (+1 SD) in prototypicality legitimacy (gradient = 0.62, $p = 0.018$). The negative slope for individuals low in prototypicality legitimacy was marginally significant (gradient = −0.50, $p = 0.054$). That men low in prototypicality legitimacy showed the opposite reaction to our manipulation as men high in prototypicality was not among our original predictions, but closely replicated the results seen in Study 1.

6.2.4. Moderated mediation

We conducted moderated mediation, testing whether the indirect effect of the experimental manipulation on desire for women to conform to dominant STEM norms, opposition to women in STEM initiative, and exclusionary intentions toward women through prototypicality threat, was moderated by prototypicality legitimacy using Hayes' PROCESS Macro (Hayes, 2013) Model 7 (Fig. 2).[7] We did so again controlling for masculinity insecurity. As masculinity insecurity was significantly correlated with each of our outcome variables (see Table 3), its inclusion in our model served as a stronger test of the predictive value of prototypicality threat. Table 4 shows the conditional indirect effect of our manipulation on each of the three outcome variables through prototypicality threat at conditional levels of prototypicality legitimacy using 50,000 bootstrapped resamples and including masculinity insecurity as a covariate.

The indirect effect of our manipulation on desire for women to conform through prototypicality threat was not reliable for participants who were at the mean in prototypicality legitimacy (prototypicality legitimacy = 2.92, roughly "somewhat disagree" on our 1–7 scale), IE = 0.02; bias-corrected 95% Confidence Interval = [−0.09, 0.16]. For those one standard deviation above the mean (prototypicality legitimacy = 4.38, above "neither agree nor disagree"), there was a reliable and positive indirect effect, IE = 0.21; BC 95% CI = [0.01, 0.53]. There was a significant negative indirect effect for individuals one standard deviation below the midpoint (prototypicality legitimacy = 1.47, roughly "disagree"); IE = −0.17, BC 95% CI = [−0.37, −0.04].

Similar patterns were found looking at the indirect effect of our manipulation on opposition to women in STEM initiative mediated by prototypicality threat and moderated by prototypicality legitimacy. There was no reliable indirect effect for participants at the mean (prototypicality legitimacy = 2.92), IE = 0.02; BC 95% CI = [−0.08, 0.15]. There was a significant positive indirect effect for participants one standard deviation above the mean (prototypicality legitimacy = 4.38), IE = 0.18, BC 95% CI = [0.00, 0.50]. Again, this was reversed such that there was a significant negative indirect effect for participants one standard deviation below the mean (prototypicality legitimacy = 1.47), IE = −0.14; BC 95% CI = [−0.37, −0.02].

Finally, the observed patterns also held for exclusionary intentions toward women in STEM. Again, there was no reliable indirect effect for participants at the mean (prototypicality legitimacy = 2.92), IE = 0.02; BC 95% CI = [−0.09, 0.15]. There was a significant positive indirect effect for participants one standard deviation above the mean (prototypicality legitimacy = 4.38), IE = 0.20, BC 95% CI = [0.01, 0.49]. Again, this was reversed such that there was a significant negative indirect effect for participants one standard deviation below the mean (prototypicality legitimacy = 1.47), IE = −0.16; BC 95% CI = [−0.35, −0.04].

[7] As in Study 1, we had no a priori predictions about the relationship between our manipulation and prototypicality legitimacy on our outcome variables without the inclusion prototypicality threat in our model. Mirroring patterns of results shown in Fig. 3, post hoc analyses revealed a significant interaction between our manipulation and prototypicality legitimacy on desire for women to conform ($p = 0.041$), a marginal interaction on opposition to women in STEM initiatives ($p = 0.066$), and a significant interaction on exclusionary intentions toward women ($p = 0.019$).

Table 4
Study 2 conditional indirect effect of perceived men in STEM careers majority loss on desire for women to conform, opposition to women in STEM initiative, and exclusionary intentions toward women in STEM through prototypicality threat at low (−1 SD), moderate (Mean), and high (+1 SD) levels of prototypicality legitimacy.

Conditional level of prototypicality legitimacy	Indirect effect	Bootstrapped standard error	Bias-corrected lower limit	Bias-corrected upper limit
OUTCOME = desire for women to conform				
−1 SD (1.47)	**−0.17**	**0.08**	**−0.37**	**−0.04**
Mean (2.92)	0.02	0.06	−0.09	0.16
+1 SD (4.38)	**0.21**	**0.13**	**0.01**	**0.53**
OUTCOME = opposition to women in STEM initiatives				
−1 SD (1.47)	**−0.14**	**0.09**	**−0.37**	**−0.02**
Mean (2.92)	0.02	0.05	−0.08	0.15
+1 SD (4.38)	**0.18**	**0.12**	**0.00**	**0.50**
OUTCOME = exclusionary intentions toward women				
−1 SD (1.47)	**−0.16**	**0.08**	**−0.35**	**−0.04**
Mean (2.92)	0.02	0.06	−0.09	0.15
+1 SD (4.38)	**0.20**	**0.12**	**0.01**	**0.49**

Note. SD = standard deviation. Bias-corrected 95% confidence intervals were calculated using 50,000 bootstrap samples (with replacement). Significant conditional indirect effects ($p < 0.05$) are highlighted in boldface. Masculinity insecurity is included as a covariate.

6.3. Discussion

Study 2 replicated and extended the findings from Study 1. Men professionally employed in STEM who felt that their subgroup's prototypicality in their career was legitimate showed greater prototypicality threat when they were led to believe that women in STEM initiatives would be successful than when they thought such initiatives would fail. Prototypicality threat was, in turn, associated with stronger demands for women to conform to men's norms in STEM, greater opposition to women in STEM initiatives, and more exclusionary intentions toward potential women coworkers. These effects held even controlling for individual differences in concerns about masculinity.

Interestingly, Study 2 replicated the unexpected finding in Study 1 that men low in prototypicality legitimacy reported lower levels of prototypicality threat when told that the number of women in STEM would increase, rather than remain the same. Although not predicted a priori, the replication of this pattern of findings across the two studies suggests that the utility of future research that focuses on which men may be welcoming of, rather than threatened by, gender diversity efforts.

7. General discussion

Across two experiments, men who believed that their prototypicality in STEM (as a field of study in Study 1 and as a profession in Study 2) was legitimate reported greater prototypicality threat when informed that women in STEM initiatives were successful in bringing more women into STEM than when these initiatives were stalling. In turn, experiences of prototypicality threat predicted the desire for women to conform to STEM standards as defined by men, opposition to gender diversity initiatives in STEM, and exclusionary intentions toward women. This pattern of findings was demonstrated among men both studying and working in STEM, and held even controlling for masculinity insecurity in the second group. This demonstrates that prototypicality threat induced by social change has unique explanatory significance, above and beyond individual differences in concerns about masculinity. As women commonly cite hostile climates as their impetus for leaving STEM fields (Cheryan et al., 2009), this research illuminates how successful gender diversity efforts may threaten men's sense of ownership over the STEM identity, causing them to create even less hospitable climates for women successfully recruited into STEM.

7.1. Limitations and future directions

Our goal in this paper was to test a new, theoretically derived psychological mechanism (i.e., prototypicality threat) underlying men's responses to efforts to increase gender diversity in STEM, and to examine whether beliefs that men *should* define the norms of this field (i.e., prototypicality legitimacy) would moderate susceptibility to this threat. Across two experiments with different operationalizations of the theoretical constructs and two samples of men representing different aspects of the STEM pipeline, we found consistent support for our key predictions.

Despite these consistent findings, our understanding of prototypicality threat will benefit from further empirical exploration. Although it was not a goal of the present research, it will be valuable to conduct a more systematic examination of the relationship between prototypicality threat and other forms of group-based threat (e.g., Branscombe et al., 1999; Riek, Mania, & Gaertner, 2006; Stephan & Stephan, 2000). Although it is possible, even likely, that the context of increasing diversity will trigger multiple forms of conceptually distinct threats, it will be important to take each into account. If we wish to manage intergroup tensions, different forms of threat call for different interventions. For example, concerns among both men and women about competition over resources may be naturally attenuated by the anticipated growth of jobs and investments in STEM (Olson & Riordan, 2012). Concerns specific to men about the potential loss their prototypicality, on the other hand, may be harder to mitigate. One potential approach may be to capitalize on past work showing that efforts to portray superordinate categories in a way that is characterized by complexity (e.g., making diversity a defining characteristic of STEM) inhibits subgroups' ability to claim prototypicality in those domains (Ehrke, Berthold, & Steffens, 2014; Waldzus, Mummendey, Wenzel, & Weber, 2003). By reducing men's perceived claims to represent STEM in this way, we may also reduce their susceptibility to prototypicality threat.

It is also worth discussing the unexpected finding that men low in prototypicality legitimacy (i.e., those who strongly disagreed with the notion that men *should* represent what it means to be in STEM) showed the opposite effect of men high in prototypicality legitimacy in response to our manipulation (i.e., they showed a decrease rather than an increase in prototypicality threat in response to information that women in STEM initiatives were succeeding versus stalling). Despite the fact that this finding was not predicted, it represents a valuable silver lining to our research – the possibility that some men may embrace, rather than reject, the prospect of more women entering STEM. This finding underscores prototypicality legitimacy's role as a novel and influential individual difference moderator determining susceptibility to prototypicality threat. Additionally, further study of the origins and malleability of prototypicality legitimacy may highlight new strategies for averting or reducing the activation of prototypicality threat among dominant group members and the negative consequences associated with this threat. In particular, interventions designed to dispel beliefs about innate gender differences (Dar-Nimrod & Heine, 2011; Keller, 2005) may be an effective strategy to reduce men's apprehensions about more women entering STEM, and convert some into active allies in support of this change (Drury & Kaiser, 2014).

Another potential critique of our studies is the relatively liberal leaning of our samples. We suggest, however, that samples that lean left have the benefit of providing a more robust test of our predictions. Specifically, more conservative samples might show greater willingness to express negative attitudes toward women in STEM, resulting in stronger effects overall. In contrast, our findings show that even men who self-identify as liberal in their political beliefs, and who may explicitly express support for gender diversity programs, are susceptible to concerns that the strong association between men and STEM may be threatened by the influx of more women into the field.

Finally, it is important to acknowledge the limitations regarding the use of mediation analyses in this paper. Although our findings were consistent with the causal chain suggested by our theoretical approach, our reliance on self-report attitudinal measures for both our mediating mechanism and our outcome variables suggest that we must be cautious about over interpreting the causal links in our mediational pathway (Spencer, Zanna, & Fong, 2005). More definitive evidence of prototypicality threat as the cause of defensive reactions may be derived from alternative methodologies such as the inclusion of behavioral outcome measures and/or longitudinal designs.

7.2. Implications for the future of women in STEM initiatives

Our findings highlight the need for research on gender diversification in STEM to consider the specific motivations men may have for curtailing women's representation in these fields. As men are gatekeepers in the STEM domain (Moss-Racusin et al., 2012), their defense of their gender's prototypicality may profoundly limit the long term effectiveness of women in STEM initiatives. Recall, it was not the actual presence of more women in STEM, but merely the expectation of this, that threatened men to the point of expressing exclusionary intentions toward women peers. Despite great investment in recruitment strategies, men may undermine these efforts by driving women out of STEM. A missing piece of the leaky pipeline metaphor may be that when men see more women entering the pipeline, they create more leaks. It is important to highlight again, however, that this reaction was only true for a subset of the men we studied, those who felt that their gender's claim to represent what it means to be in STEM was legitimate. Although only a subset, a single hostile team member or supervisor is often enough to sour a professional or educational climate.

Beyond the context of women in STEM, efforts to increase other forms of diversity such as ethnicity and sexual orientation stand to benefit from the approach and findings of this research. Only by understanding and accounting for the precise triggers and conditions of the dominant group's sense of threat, especially those previously overlooked (e.g., prototypicality threat), can we ensure our efforts to increase diversity will be embraced, rather than challenged, by those whose support is needed most.

Appendix A. Supplementary data

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.jesp.2016.12.014.

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