International Journal of Gender, Science and Technology
http://genderandset.open.ac.uk

"She Won't Make Me Feel Dumb": Identity Threat in a Male-Dominated Discipline

Laura E. Hirshfield

University of Michigan, USA

ABSTRACT
Fields of study in college and graduate school, as well as careers in science, technology, engineering and mathematics (STEM) continue to be chosen more frequently by men than by women, contributing to the gendered wage gap. Using data from interviews with undergraduate physics students, I challenge prevalent notions of 'critical mass,' and argue that women's hyper-visibility in male-dominated STEM fields produces identity threat - concern that their perceived inadequacies are attributed both to themselves and to women as a group. In response, women seek out 'friendlier,' less identity-threatening environments, thereby clustering together in female-dominated work spaces. Implications for future research and policy on gender in STEM fields are discussed.

KEYWORDS
Gender; Science; Technology; Sociology; Self-Concept; Higher Education; Qualitative Interviews

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INTRODUCTION

While the wage gap between men and women in the United States is slowly narrowing, women still earn only about 75-80% as much as men (IWPR, 2004). Many argue that this wage gap exists because of the tendency for men and women to choose (or, as more structural theorists would claim, be funnelled into) different career paths (Davies and Guppy, 1997; Machin and Puhani, 2003; Weinberger, 1998; Jacobs, 2003). Though women in the U.S. have gradually been breaking into fields in which they were previously underrepresented (e.g. law and business), they are still a minority in science, technology, engineering and mathematics (STEM) fields of study, and therefore in STEM careers. As a result, women's lack of math and science credentials, and their consequent underrepresentation in STEM careers, may be one of the leading causes of the gendered wage gap. Further, while most research on the gendered wage gap shows continued disparities, there is some evidence that suggests that when women choose male-oriented career paths, they are generally successful at receiving comparable jobs and salaries (Morgan, 2008; Morgan, 1998). This further substantiates the need to examine why women tend not to be educated or trained for these careers.

One of the most common metaphors used to describe and understand the dearth of women in science, technology, engineering and math is that of the 'leaky pipeline' through which women travel on their path to STEM careers (Luckenbill-Edds, 2002). Women opt out at various stages, taking fewer math and science courses in secondary school, switching out of STEM fields or 'majors' during college, and choosing not to pursue STEM careers post-graduation[i].

In a review of the literature on women in science, Blickenstaff (2005) described nine possible forces (both individual and social) behind this 'leaking': biological gender differences in ability; girls' lack of preparation in and poor attitude towards math and science; the absence of female role models; science curricula and pedagogy that is irrelevant to girls and favours boys; a chilly academic climate; cultural pressure to conform to gender roles; and, the inherent masculine worldview in scientific epistemology.

In this paper, I argue that the combined effect of several of these factors leads to an additional barrier for women in science, that of identity threat. Identity threat occurs when a person 'appraises the demands imposed by a stigma-relevant stressor as potentially harmful to his or her social identity' (Major and O'Brien, 2005). In the case of women in physics, negative stereotypes about women in science (a consequence of gender socialisation and the intensely 'masculine' culture of science and science departments), combined with women's relatively low representation in scientific fields (tokenism), leads women to experience this identity threat. Identity threat may then lead to gender segregation within STEM departments, which reproduces negative stereotypes about women in science and

may explain their overrepresentation in lower-prestige subfields within their disciplines.

I begin this article with a review of the sociological literature regarding the masculine culture of science and gender socialisation which helped to shape and inform both the formation and analysis of this project. Next, I describe the discipline of physics, the case I chose here, in more detail, as well as the qualitative methods I used. I then discuss the ways in which physics as a discipline is gendered, and, more specifically, how this has led women in physics to experience identity threat. Finally, I conclude by discussing the implications of this kind of identity threat for women training in STEM disciplines.

THEORETICAL BACKGROUND

The Masculine Culture of Science

In her frequently-cited work, *Reflections on Gender and Science*, Keller (1985) introduced the notion that science was gendered, and that its gender was male. Discussing women in science she described this genesis as:

> 'a network of interactions between gender development, a belief system that equates objectivity with masculinity, and a set of cultural values that simultaneously (and conjointly) elevates what is defined as scientific and what is defined as masculine' (p. 89).

This 'historically pervasive' association is problematic in that as gender and science continue to be intertwined, science may be affected by systems of patriarchy and sexism. Gender may be imbued with the value placed on science, perpetuating a hierarchy in which science's high status in our culture helps to increase the status of that which is 'masculine' (Keller, 1985). Further, this association between male cognitive authority and science creates a system in which men's interpretations of the world are more often taken to be accurate and true, while women's are more likely to be questioned and considered false. Thus, women's ability to add to the scholarly landscape is greatly diminished (Long and Fox, 1995).

Empirical work suggests that the masculine culture in science departments does in fact cause trouble for female faculty and students. For example, in a study of two science departments at a single American university, Ferreira found that the low numbers of women faculty and students helped sustain a departmental culture based on the traditional male cultural norms of individualistic competition and aggressiveness (Ferreira, 2003). Schiebinger (1999) also found that women in science see the culture as aggressively competitive and rife with 'macho-ness,' where colleagues try to prove themselves superior to others, are fiercely combative, and ignore other people's ideas. While this culture of competition may be detrimental and uncomfortable for both men and women, women may be more likely to fall victim to the weeding-out practices and competition in science than men because they are not socialized to be as comfortable with competition and because 'competition intensifies their culturally induced sense of doubt' (p.87).

Gender Socialisation

Much of the research conducted to explain women's lack of participation in STEM has focused on individual factors such as differences in ability/achievement, interest, and course-taking. While differences in mathematical and scientific ability are often cited as a major cause of the shortage of women in STEM fields, studies that have tested mathematical and scientific ability and achievement have generally found few differences in mean scores (Hyde et al., 1990; Entwistle et al., 1994; Fan et al., 1997), with one notable and controversial exception (Benbow and Stanley, 1983). Women's tendency to have different interests and goals than their male peers, which in turn affect the courses and field of study they choose, has also been named as a possible cause for women's absence in STEM careers. Indeed, many studies of differences in interest by gender in math and science find that one of the reasons women are underrepresented in STEM fields is because participation in math and science does not fit with their self-concepts and gender roles (Lee, 1998; Lackland and DeLisi, 2001; Sax, 1994). Similarly, the gender gap in course-taking patterns of STEM fields has declined very little, and most of the articles examining these patterns cite differential interests and confidence (caused by gender socialisation) as the reason for the gap (Updegraff et al., 1996; Catsambis, 1994; Correll, 2001).

Rather than inherent, natural characteristics of men and women, these gender differences in ability, interests, and course-taking are more likely the consequence of macro-level forces of gender socialisation. However, it is extremely dangerous to simply focus on the differences between boys and girls (or men and women), especially since the similarities between the two groups are often much greater than the differences (see Thorne, 1993). Nevertheless, beliefs about gender and the role these beliefs play in gender socialisation exert a powerful influence over the choices and experiences of men and women. As such, they are an important area of focus in research on women in science. Accordingly, in an exploration of the relationship between gender roles and decision-making processes, Eccles (1987) argued that men and women's socialisation may lead them to place differential value on core personal values (e.g. interest in people versus interest in things).

This kind of gender socialisation in turn affects women's entry into science and math in several important ways. First, it teaches women about what kinds of careers and interests they 'should' aspire to. Math and science, for example, are considered to be male domains. In a shocking illustration of this, Schiebinger (1999) stated that in 1992, a new talking Barbie doll (a classic symbol of American femininity) was programmed to say, 'Math is tough…let's go shopping,' implicitly telling her millions of owners that being a girl meant thinking math was hard, and that shopping was a more gender-appropriate pastime than doing math.[ii] As Fennema and Peterson (1985) explained, 'Mathematics is not seen as an appropriate domain for females. Therefore, achievement by a female in the mathematical domain results in her not fulfilling her sex role identity adequately…'(p.25) Similarly, science is also perceived to be a masculine pursuit; dozens of studies of children's images of scientists over the years have found that when asked to draw a scientist, most children draw men.[iii] Further, when asked to

describe them, both boys and girls typecast mathematicians and scientists as 'loners who have little time for their families or friends because they work long hours in a laboratory on abstract problems that typically have limited immediate social implications' (Boswell, 1979 cited in Eccles, 1987).

Another major result of gender socialisation is that men and women are trained to have very different conversational and interactional styles, which in turn affects communications in the classroom and at the workplace. Tannen (1990), whose work in this area is well known, if controversial, claimed that male-female interaction is akin to cross-cultural communication. In her view, male 'culture' and the 'language' they are socialized to use is hierarchical and differentiating, while female 'culture' and 'language' emphasizes connection and intimacy. These differences in conversational style affect interactions at work and in the classroom, so women may sound more modest than men and men may be more likely to interrupt than women. While such communication difficulties affect men and women regardless of their chosen field of study or career, science's emphasis on the masculine affords male communication styles more power and legitimacy, and thus, women in STEM fields may be forced to negotiate awkward interactions more frequently than their male peers (Schiebinger, 1999).

An additional important consequence of gender socialisation is its implications for confidence, which, as previously noted, is a key factor in women's decisions to leave STEM fields. It has been well documented that while women underestimate their own chances for success, men tend to overestimate them (Schiebinger, 1999; Eccles, 1987). Some suggest that this is in part due to women's 'fear of success,' an ongoing area of interest and debate in psychology research since Horner's unpublished doctoral dissertation in 1968. Horner found that, when compared with men, women were much more likely to express motives to avoid success than to achieve it (Horner, 1968). According to her theory, women are placed in a double bind, for they 'do not want to fail, but they also do not want to succeed, for fear of social rejection, negative consequences, and loss of femininity' (Gravenkemper and Paludi, 1983). While fear of success is difficult to measure, there is some evidence that women tend to experience it more frequently than men (Fried-Buchalter, 1997). The theory has been criticized, however, for attributing this greater degree of fear of success to inherent, global characteristics of females, rather than focusing on the effects of gender socialisation on these processes (Pfost and Fiore, 1990). Critics argue, instead, that because women who are successful in nontraditional occupations deviate from societal norms and can thus suffer negative consequences for success, women's apparent fear of success may instead reflect a realistic anticipation of negative consequences (*ibid*).

Regardless of the reasons behind men's and women's differential understandings and fears of success, it is clear that there are also differences in their attribution of accountability for those successes (and failures). For example, in a study of undergraduates in the United States, Ware et al. (1985) found that:

> 'Men tended to place responsibility for difficulties outside of themselves - to explain their problems in terms of the inherently difficult nature of the course material or the poor performance of instructors. Women, in

> contrast, were more likely to fix the blame internally – to cite their own inadequacy as the source of the difficulty' (pg. 79).

If women are more likely to blame themselves for poor performance than men, math and science classes, which are notoriously discouraging due to low grades and steep curves, may be especially damaging to women.

The Case of Physics

As a discipline and department that is one of the most male-dominated of the sciences, physics provides a particularly interesting area of investigation. At the faculty level, only 10% of professors in degree-granting physics departments are women. In addition, despite record gains in women's participation in physics in the U.S. (in 2003, women earned 22% of the bachelor's degrees in physics and 18% of the PhDs in physics), physics is not attracting women as quickly as other science fields such as astronomy, chemistry, mathematics and biology (Ivie and Ray, 2005). Internationally, the number of women in physics is also relatively low. In most countries, about 25% of undergraduate degrees in physics and 20% of doctorates in physics are granted to women (*ibid)*. The demographics of the physics department at the American university where I collected my data were quite similar to those nationwide. Nine percent (5 out of 56) of full-time professors[iv], 21% of undergraduate students, and 23% of doctoral students in the department were women[v] (Rainwater, 2006; Office of Budget and Planning, 2006).

DATA AND METHODS

In an attempt to further explore the combined influences of gender socialisation and the masculine culture of science, I conducted a qualitative interview study with undergraduate physics majors. Qualitative and interview methods are particularly useful for identifying tone and meaning-making in individuals' experiences, and were thus particularly suited to my research agenda. Further, since such methods have been used very little to examine the experiences of men and women in science, this study was conducted in an effort to begin to fill this gap in our understanding.

The data for this study were seventeen semi-structured interviews of undergraduate physics majors (12 female, 5 male) at a large, Midwestern, research-oriented university. Students were recruited through several department-wide emails sent to undergraduate physics majors and an announcement at a student-run, departmental group. Word-of-mouth was also an important factor in recruitment, as several participants referred their friends to the study. Thus, this may have led to an overrepresentation of students who felt strongly about issues of "climate" or who felt that they wanted their voices to be heard. However, my sample of respondents was fairly representative of the overall demographics in the physics department, with one obvious exception – an overrepresentation of women[vi]. Twelve of my respondents identified as White, one as South Asian, and two as Asian-American. All respondents were heterosexual, though one woman qualified her response by adding 'mostly.' Respondents varied by year of schooling, though most were upperclassmen (3 freshmen, 2 sophomores, 6 juniors, and 6 seniors)[vii]. Most respondents grew up in the Midwest. The sample was quite

diverse socio-economically. Parents' incomes ranged from a combined income of below $25,000 to over $300,000, though most reported their parents' income to be somewhere between $50,000 and $150,000.

The interviews for this project were collected in two phases. Interviews began in Winter of 2005 and were conducted throughout the Winter semester, and, after a hiatus during the Spring/Summer semesters, were resumed in the Fall of 2005. In the intervening time, after an initial review of the data, my initial research question – broadly, to understand the ways that physics students chose to pursue physics – became a more focused examination of men's and women's experiences within the department.

Interviews were conducted in a small, semi-private room in the Sociology department, or in an office reserved for undergraduate Physics majors. Each was audio-taped and lasted about one hour. There were brief interruptions by classmates or peers during three of the interviews, though the rest were conducted without interruption. Interview topics included parents' and siblings' educational history; respondents' experiences in high school; the choice to go to college and which college to choose; the choice of college major; and, future plans. All the topics were covered in each interview, however, respondents were asked to discuss their decision-making processes and, as such, the order of topics was fluid and was guided by their responses.

After respondents had described their decision-making processes about their majors and about their future plans, I asked them to address how their identity (gender, race, socioeconomic status, and sexual orientation) might have affected their choices and experiences. Respondents in the second phase of interviewing were also asked specifically to address issues of gender, though all respondents previously had spontaneously discussed the influences of their gender on their academic experiences without prompting. In fact, with the exception of the South Asian student, who briefly discussed his racial identity, gender was the only social identity acknowledged and described as consequential by any of the respondents.

I was very aware during all of these interviews of my own identity as a young female graduate student. In her discussion of dilemmas in feminist fieldwork, Wolf (1996) explains that power differentials between the researcher and her subjects must be acknowledged and accepted. Generally the power in interview studies tends to be held by the researcher, who usually is more educated and wealthier than those she studies, thus she is thought to be 'studying down.' She also has greater power because she is in a position to report upon the study—to portray the subject in selective ways that may or may not reflect the subject's meaning. In this case, I felt at times that my respondents believed that I was 'studying up' rather than down, because my 'scientific' work as a sociologist was so much 'softer' than their 'hard' science training. At several points during the interviews, students apologized to me for disparaging classes in the humanities and social sciences and looked at me as if embarrassed to be looking down upon fields which they felt I represented. These points in the interviews were particularly rich moments that often provided me with subtle and interesting insights into participants' beliefs

about gender, science and knowledge. These insights have informed my subsequent research, and I believe that this aspect of social scientists' work on the 'hard' sciences seems to have myriad important effects on the field, and should continue to be studied more fully at a later date.

After the tape-recorded interviews were transcribed by professional transcriptionists, I coded them using NVivo qualitative data analysis software to explore themes that arose both from my own research questions as well as from the data itself. The themes I expected to discover included feelings of tokenism, departmental concerns about gender, encouragement of women in science, and 'gender issues'. Themes that emerged from the data included female mentoring, gendered topics/subfields in physics, and what I called 'female clustering.'

DISCUSSION

The Gendering of Physics

> "If you're a male you're sort of pushed toward math or science. If you're female, you're pushed toward, you know, anything but."
>
> *-Ashwin*[viii]*, male, Senior*

> "We've found that there's sort of a reluctance among the guys to sort of take us seriously. I mean, they'll be much more likely to take one of their male colleagues seriously and think that they are capable. But coming in, you really have to prove yourself first before they start to believe… whereas with guys that's not the case."
>
> *- Kathryn, female, Senior*

As expected, both gender socialisation and the 'masculine' culture of science seemed to have a considerable effect on the experiences of my respondents, especially the women in my sample. Stereotypes, both about women and about scientists, led female students to view themselves as abnormal, or 'weird' in their pursuit of science. For example, Samantha, a sophomore, when describing her joy in studying physics at a local amusement park, recounted in a bemused voice, "I'm like, 'Why am I liking this so much? It's science…'" Because she had been taught to believe that science was hard and that girls did not like it, she found it strange and "antithetical to what I thought I liked and what I'd always focused upon." Several women also described others' surprise when they told people their major; for example, Amy, a freshman explained, rolling her eyes, "When you [a girl] tell people that you do physics, they'll stay stuff like 'wow, *that's* different…'"

The women in my study also perceived that differences in communication styles between men and women seemed to impact their experiences both in the classroom and in study groups. According to their understanding, a major consequence of these differences was that men were more likely to dominate conversation and to interrupt their peers in study groups, creating competitive atmospheres that their female peers (and some of their male peers) find distasteful. Further, the women in this study reported that men are much more likely to interrupt female colleagues and to discount their contributions. When describing the difficulties of being the only woman in a study group, Jennifer (a junior) explained that sometimes "I'll say something, and [the guys] won't listen,

and someone will say the exact same thing a few minutes later and I'll think... I'll say it to them, because I have a big mouth, 'You're not listening to me, because I'm a girl, huh?'"

Many of the women in the program feel that they are ignored when they are in academic settings– in fact, this problem is a constant topic of conversation in the support group that these women have formed to deal with the issues of being female in a science major. This group, formed by a group of undergraduate students in 2002, holds bimonthly meetings with female professors, postdoctoral fellows, graduate and undergraduate students, to discuss issues of professionalization and to provide science outreach to local high school women. Jill (a junior), recounting the discussions that often arise during these meetings, said "from what I've heard from other students and from professors who hear stories, a lot of times if you get a group that's like one girl and three guys, the guys will kind of dominate, and even when she knows what she's talking about, they tend to dismiss her." Commiseration about this problem seems to help alleviate some of its negative consequences, since

> "it's just good to know that you're not the only one who guys don't listen to when you're working in groups, so it's not like, 'Oh, are they just not listening to me because I'm a girl and I'm really stupid?' Like, 'no, we've all had this experience, you're probably not stupid.'" [laugh]
>
> *-Samantha, female, Junior*

Samantha's assumption that her male peers might not be listening to her because she is stupid highlights another influence of gender socialisation on women's experience in science – that of women's tendency to have lower self-confidence. Eloquently describing her impressions of the difference between herself and her male peers, Dana explained,

> "[It's] not necessarily that the guys are so much smarter than girls. But guys by nature…they're just much more full of themselves, and are very like 'I'm the shit….' I'm much more... I'm not sure. You know, I'm a little unsure of myself…There's something... [a] personality flaw with physics major boys...they want everyone to think that they're the smartest person on earth. And I feel like maybe...maybe it's girls in general, maybe it's just me. But my attitude is more of like, you know, I don't give myself enough credit as opposed to too much, you know?'
>
> *-Dana, female, Junior*

Whether or not this gender difference in self-confidence is an artefact of nature or a 'personality flaw,' rather than the consequence of gender socialisation, women's lack of confidence is an especially difficult obstacle in science, since its culture is so permeated with masculine norms of competition and aggressiveness.

Stigma and Stereotype Threat for Women in Physics

In early 2005, Lawrence Summers, the President of Harvard College, spoke at the NBER Conference on Diversifying the Science & Engineering Workforce, where he

suggested that 'innate differences' between men and women might help explain the lack of top-level female professionals in science and engineering. These comments caused debates to erupt both in the popular press and amongst scholars in the field of women in science. All debates aside, Dr. Summers' remarks put into words (and gave validity to) one of the most common, deleterious stereotypes about women – that they simply are not as good at math and science as men.

Arguments such as Summers' reinforce our society's stigma against women in science, granting legitimacy to the common belief that women are less represented in science because they are just not good enough to be there. In the case of math and science fields, being a woman is stigmatized, or is, in Goffman's (1963) terms, 'an attribute that is deeply discrediting' and that reduces the bearer 'from a whole and usual person to a tainted, discounted one' (p.3). Link and Phelan (2001) extended this theory further, defining stigma as the process through which 'elements of labelling, stereotyping, status loss, and discrimination co-occur in a power situation that allows the components of stigma to unfold.' In the case of women in science, gender socialisation and the gendered nature of science lead to an environment in which they are stigmatized simply by the fact of being female; they must face the associated consequences regardless of whether or not they live up to negative stereotypes.

Sociologists and social psychologists have conducted many studies examining the costs of stigma and related phenomena. One of these negative consequences, stereotype threat, has become a major focus of social psychological research. First described by Steele and his colleagues, the theory of stereotype threat states that one underperforms when negative stereotypes about one's racial or gender group are activated (Steele and Aronson, 1995; Steele, 1997). In an article focused on examining women's performance on math tests, Spencer et al. (1999) explained the theory behind stereotype threat:

> When women perform math, unlike men, they risk being judged by the negative stereotype that women have weaker math ability. We call this predicament stereotype threat and hypothesize that the apprehension it causes may disrupt women's math performance (pg. 4).

In other words, this theory posits that women perform poorly on math tests because they fear that they will live up to negative stereotypes about women's math ability (by getting a low score), and they are so distracted by this fear that they actually do perform more poorly. Numerous studies support this theory (Keller and Dauenheimer, 2003; Spencer et al., 1999; Steele, 1997; Smith and White, 2002; McIntyre et al., 2003, Marx and Roman, 2002). While stereotype threat is usually examined by explicitly stating stereotypes in experimental conditions, it can also be implicitly activated, suggesting that implicitly-activated stereotypes about women in STEM fields could affect their performance in those areas (Smith and White, 2002). In fact, in a study of undergraduates, Steele and his colleagues (2002) found that first-year and final-year female undergraduates in male-dominated academic areas reported higher levels of discrimination and stereotype threat than women in female-dominated academic areas, as well as men in either a

male- or female-dominated academic area. In addition, women in male-dominated academic areas were most likely to report considering changing their major.

Indeed, the women in this study frequently referred to their awareness of their identity as women in a field dominated by men. Several of my participants expressed 'feeling weird' being in the minority, though they seem to 'get used to it' quickly:

> "It feels so weird being the only girl in a class."
>
> *-Samantha, female, Junior*

> "Um, well, I noticed like the very first time I walked in, I was a little bit late, and all those people were already gathered at the front of the classroom, and I saw this one girl I know and all the rest of the guys. And it was kind of...it was strange, [being the only girl] but I mean I've gotten used to it."
>
> *-Emily, female, Sophomore*

> "In the beginning I felt a little bit weird [being the only girl]..."
>
> *-Dana, female, Junior*

While nearly all of my female participants mentioned their awareness of gender in the classroom, male students were much less likely to talk about their gender or about the gender breakdown in classrooms.

The women in my sample also frequently mentioned stereotypes about women in science. As Samantha explained,

> "It feels really bad to get the exam back, and [get] you know, like 50% , 70% and then add to that, you know, the president of Harvard going in the national media and saying 'women are just bad at math,' and then you're looking at your exam with the 50… that was a bad feeling. I had a little trouble shaking that….You know you'd read these things like, 'Oh, you know, this shouldn't make you feel bad. If women know they're good at Physics than that shouldn't bother them.' But it does. Because, even if you're good at something, you have, you struggle with it until you finally do get it, and while you're struggling if you have this little thing it's like 'Maybe it's because you're a girl,' like that doesn't help, it really is detrimental."
>
> *-Samantha, female, Junior*

Physics students often struggle with the experience of managing their emotions after doing poorly on tests, but the combined forces of lower self-confidence caused by gender socialisation and negative stereotypes about women's scientific ability unite in creating an environment that may be particularly damaging to women's senses of self.

Not all of these women's responses to stereotypes are negative, however. Many state that they are particularly aware of the importance of sharing their accomplishments with others to 'prove' that women can be successful in science

too. Thus, 'in-reach' projects, or those designed to form a link between female undergraduate science majors and younger female students at local schools, are a strong focus of the undergraduate women's physics support group, and are often cited as the function of the group that members most enjoy. Heather explained that she liked telling these young women, "Hey, you're a girl, and guess what? We do physics, and you can do physics too." Several of the female respondents also talked about their desire to counter other people's stereotypes about females not being good at science:

> "Honestly I think that choosing physics may have...I may have been more likely to do that, actually because I was female. Because I'm really stubborn. And if you say girls can't do it, I'm going to be like, 'Yes, they can! - I'll show you.'"
>
> *-Jill, female, Junior*

> "I want to be visible, and be just, like, I keep thinking I want to be like a counterexample to people who agree with people like Larry Summers, like 'women are stupid in physics,' well if I get all As in physics I can show that to them or something." [laugh]
>
> *-Samantha, female, Junior*

In this way, stereotypes about women may be acting in a positive manner – encouraging women to succeed in science to contradict negative opinions about women in their field. Conversely, the pressure of their own expectations for themselves (that as women they must succeed even more than their male peers to disprove negative stereotypes) may lead girls to feel increased pressure and a destructive phenomenon known as identity threat.

Identity Threat and Female Clustering in Physics

A related, more macro-level consequence of negative stereotypes and stigma is what Major and O'Brien (2005) called 'identity threat.' Identity threat occurs when a person 'appraises the demands imposed by a stigma-relevant stressor as potentially harmful to his or her social identity, and as exceeding his or her resources to cope with those demands' (p.399). Identity threat, like stereotype threat, creates many involuntary (negative) responses in those who experience it. These include physiological reactions such as anxiety and arousal and social consequences like excessive caution in threatening situations. Victims may cope with identity threat by attributing negative events to external forces rather than to themselves, disengaging their self-concept from those domains that are threatening (i.e. math for women or school for African-Americans), and increasing their identification with their minority group.

While stigma and identity threat are crucial concepts to explore when examining women's experience in science, it may be that these theories, which apply to all stigmatized groups, do not predict how these situations play out for different types of stigma. As Yoder (1991) explained in her review of Kanter's classic theory of tokenism, 'in attributing these negative consequences to token numbers alone (rather than to gender), Kanter diverted attention from their root cause, sexism, and it's manifestations in higher-status men's attempts to preserve their advantage

in the workplace'(p.189). Similarly, an examination of identity threat and its manifestation in math and science must also focus on the gendered mechanisms through which negative stereotypes and ensuing identity threat is both tolerated and recreated. In their study of women in science, Ware et al. (1995) eloquently explained the consequences of identity threat:

> '[Women] are likely to feel that they must do better than their male counterparts in order to be considered equal; that they must demonstrate their worthiness through superior competence before being accepted or taken seriously; and that their mistakes or inadequacies risk being construed as characteristic of women in general.' (pg. 79)

Findings from this study, however, suggest that these negative outcomes of identity threat are made even more damaging by the gendered nature of science and by women's socialisation to be more timid and less self-assured than their male counterparts.

In a remarkably clear description of the experience of identity threat, Samantha articulated the difficulty of working in mixed-gender study groups. She explained,

> "Especially in the intro classes, where you work in groups, always in the problem sessions, and just because of the gender breakdown I keep ending up in these groups where I'm the only girl. And, like, I would know that this other guy in the group is not as good at Physics as me, but you know, when I make mistakes on a problem all the guys are like, 'Why are you doing that, I don't understand, like, you're stupid,' and when this guy who I'm better than would make a mistake, they'd be like, 'Oh, it's just a mistake, you're…we know that you're still smart, let us help you…' You know. But, not so much, if I make a mistake it's because I'm just not good at physics."
>
> *-Samantha, female, Junior*

Rather than being judged by the same standards as the other men in the group, Samantha feels that her mistakes are given greater significance, and that they are used as an indication that she is 'stupid,' and perhaps as an indication that all women are less competent at physics than men.

This account of an instance of identity threat is striking in its clarity; however, identity threat, which usually occurs at an unconscious level, is usually a fairly difficult phenomenon to identify. Its effects, on the other hand, are much more easily recognizable. In the case of the female physics students studied here, one of the most frequent effects seems to be their tendency to cluster or 'clump' together, spending their time both academically and socially with other female physics students, rather than with their male peers.[ix] While this is not surprising, given that sex-segregation is common even as early as elementary school, identity threat could be an additional catalyst for this occurrence, especially given the masculine culture of science and its resultant inhospitality for women (Thorne, 1993).

Two respondents who had been lab partners in the previous year separately explained their desire to be partners with each other as a function of the fact that they were the two lone girls in the class, despite not knowing each other previously (usually a prerequisite for choosing lab partners). When describing the process they went through in deciding to work together, both women identified the desire to avoid looking and feeling stupid in front of male peers as a motivation for their choice. As Heather explained,

> **"**So she ended up being my lab partner for [that class] because she was the only female in there. And she walked in the room, and I'm like, 'oooh, she won't make me feel dumb.' [laugh] So... I mean, I'd interacted with her before. I knew her name, but I hadn't really talked to her that much. I was like, yes, it was just, you know, because she was a girl, I knew she wasn't one of those people who stands up and says, 'Look at me, I'm so smart.'"
>
> "*And those tend to be guys?"*
>
> "Oh, yeah."
>
> *-Heather, female, Senior*

While Heather chose to work with Irene to avoid *feeling* stupid, Irene's motive seemed to be more a matter of preventing herself from *looking* stupid:

> "I find it's easier to work with the girls because I can ask them stupid questions…The class where I was with the other girl, we were lab partners. We kind of like made a point of it, because that would have been a case where I would have been asking stupid questions, and I'm not terribly adept at equipment, so I think we both wanted to work together."
>
> *-Irene, female, Senior*

While neither of these women articulated the experience of identity threat directly, their words suggest a desire to regulate the 'stupidity' that they either feel or display to others. Interestingly, neither seemed uncomfortable being or seeming stupid around women; rather, they believe that being with members of their own gender allowed them the freedom to speak and act without facing the risk of living up to negative stereotypes about women.

CONCLUSION/IMPLICATIONS

Several patterns in women undergraduates' experiences in physics emerged from these data. First, both the men and women in my sample described physics as a masculine field, and it was clear that the women in my sample were very aware that they violate societal norms and are 'weird' simply in their choice to become female physics majors. In addition, female respondents frequently described situations in which perceived differences in communication styles and confidence levels between themselves and their male peers affected their experiences (usually negatively) in the department. Further, these female physics majors were extremely aware of our society's negative stereotypes about women, and also were cognizant of the mismatch between the masculine ideals of science and such

stereotypes. Thus, in an attempt to avoid identity threat and the fear that they might confirm such stereotypes about women through their own 'stupidity,' they tended to congregate with other females (rather than males), with the end result being gender segregation within the department, and perhaps within the field as a whole.

In her classic study of Indsco Corporation in *Men and Women of the Corporation*, Rosabeth Kanter (1977) argued that it was women's numeric minority, not sexism, that caused them to face discrimination and discomfort in their jobs. She claimed that simply increasing the number of women (the token group she examined) would result in a more welcoming environment. Using Kanter's definition of skewed groups (85:15 ratio of majority to minority), researchers identified a 'strong minority' of 15% as the 'critical mass' necessary to counter tokenism and to bring about change in the workplace.[x] However, if the women in a given scientific field tend to cluster together because of the consequences of identity threat, then the concept of 'tokenism' and the subsequent push for a 'critical mass' of women in a department may be an ineffective one. Increasing the number of women will not necessarily change the dynamics of the field; women may simply become isolated in female-dominated work groups, laboratories, and at a more macro-level, in female-dominated subfields. Thus, paradoxically, increasing the number of women in science (and thus alleviating the pressures of being a 'token') may not resolve the issues of their underrepresentation, and may actually continue to reproduce negative views of women in science (Etkowitz et al., 1994).

Thus, it is imperative that researchers focus their attention on two interrelated and influential phenomena affecting women in science – the concepts of critical mass and identity threat. Increasing the number of women in a field seems to be such an obvious solution to the problem of tokenism, researchers and policy makers have neglected to thoroughly examine whether or not it is actually successful. It is possible that the masculine nature of science itself is enough of a barrier to women that increasing their representation will not have the desired effect on physics (and science) culture, and thus will not make the environment a more pleasant and welcoming one for women. In addition, negative stereotypes of women's abilities in science may affect women's experiences in the classroom and in study groups by increasing their experience of identity threat, and the subsequent desire to sex-segregate to cope with this concern may simply help perpetuate the lack of an effective 'critical mass.'

This study has several important limitations. First of all, despite the demographics of the field of physics, my sample was predominantly female. Whilst this unusual sample allowed me to focus on the concerns of a minority group whose representation policy makers and educators are anxious to increase, the voice of male physics majors was fairly absent. In addition, because this study was entirely voluntary (with no monetary reward for their involvement) students with strong views about the culture of physics were much more likely to want to be interviewed and to make their viewpoints heard, so some of the discomfort noted by participants may be overstated. Lastly, qualitative research uses small sample sizes to explore explanatory rather than causal patterns. While the size of this

sample made it difficult to make causal claims or to identify variation and complexity in my sample, the richness of the narratives allow for greater understanding of several important phenomena.

Specifically, this research provides insight into the concept of "studying up" – conducting research on a population that views the work that the researcher does as less scientific, less objective, and less important than the work that they do. The impact of this effect should be further explored in future research to better understand interviewer bias. My findings also suggest that identity threat may be one of the forces affecting women's experiences in Physics and may be a strong factor in helping them make choices within their major. Thus, further research is needed to understand how pervasive identity threat is, how much it affects women and their choices to segregate or "cluster" themselves, and whether this type of experience happens outside of the scientific realm. Additional research on men's experiences, as well (for example, whether they experience similar difficulties, if they are aware of these stereotypes about women, or how they manage their identities) will provide a perspective to better understand the environment in physics as a whole.

ENDNOTES

[i] Switching out of one's field of study, or "major" as it is called in the United States and Canada, is not at all uncommon. In fact, many first year students come into college or university undecided upon which field they wish to pursue, and may change their mind several times during the course of their college career. However, college majors, or the field of study in which students plan to obtain their bachelor's degree, are usually declared to the University, via a student's University-designated advisor, early in a student's University career.

[ii] Though it should be noted that the makers of Barbie removed this statement from her repertoire after women's groups protested.

[iii] For an excellent review of this literature, see Finson, K.D. 2002. Drawing a scientist: What we do and do not know after fifty years of drawings. *School Science and Mathematics*. 102 (7): 335-346.

[iv] Statistic based on departmental make-up in 2006.

[v] Statistics calculated based on degrees conferred between 2000-2005.

[vi] This overrepresentation, while quite useful for my analysis, was not my original intention. However, after I expressed my concern about finding enough women to participate in my study given their low representation in the department, one of my participants focused her recruitment attempts mainly on her female peers, and the subsequent social-network sample I obtained was thus heavily female.

[vii] In American terminology these terms correspond roughly with years in school, with four years of college/university being the norm for students to earn a degree. Thus, freshmen are in their first year at the university, sophomores are in their second year, juniors are in their third year, and seniors are in their fourth and final year.

[viii] All names have been changed

[ix] It is important to note, however, that this segregation in the physics department is far from absolute.

[x]Critical mass is an especially apropos term to use for the dilemma of women's underrepresentation in science, since the concept of critical mass is borrowed from nuclear physics, where it refers to the quantity needed to start a new situation or process. For a more thorough discussion of critical mass theory, see Dahlerup D. (1988). 'From a Small to a Large Minority: Women in Scandinavian Politics', *Scandinavian Political Studies* 11, No. 4: 275-6.

Acknowledgements:
I would like to thank Karin Martin, Aaron Kimel, David Hutson, Emily Kazyak, Zakiya Luna, Carla Pfeffer, Kristin Scherrer, and especially Katherine Luke, for their encouragement, support, and comments on earlier drafts of this article. I also want to thank the anonymous reviewers of a previous version of this article for their kind and helpful feedback.

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