# AC 2011-704: EXAGGERATING THE TYPICAL AND STEREOTYPING THE DIFFERENCES: ISOLATION EXPERIENCED BY WOMEN IN STEM DOCTORAL PROGRAMS

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# Exaggerating the typical and stereotyping the differences: Isolation experienced by women in STEM doctoral programs


## Abstract

This paper describes the initial results of a qualitative, longitudinal study designed to understand how career and educational choices unfold for women in graduate school over the course of an entire academic year. Participants recruited from private and public research universities across the U.S. submitted Internet journal entries (blogs) and/or were interviewed biweekly during fall and spring semesters. Ethnographic techniques[1] were employed to elicit details of concrete incidents. Constant comparative analysis[2] was used for understanding journal entries and interview transcripts. A common experience among participants in both components of the study was "feeling different" from an implied institutional norm, according to preliminary results. Students sometimes self-isolated in order to meet a perceived need to present themselves as capable and as "fitting in" with the institutional norm implied in competitive departmental climates. Reliance on remote communication provided by advanced technology as well as the process of academic specialization are also related to the isolation experienced by the women participants. In the absence of the buffering aspects of social integration,[3] discouraging incidents led students to question their competence, their "fit" in the institution and by association, the profession and future aspirations. The paper further explains how the process of academic and social isolation unfolds and is negotiated over the course of doctoral studies, as reported by the participants.


## Introduction and Literature Review

Women are more engaged in science, technology, engineering, and mathematics (STEM) than ever before, holding the majority of undergraduate degrees in certain STEM-related disciplines.[4] However, there is evidence that what are known as leaky pipeline and glass-ceiling effects remain especially strong in STEM fields.[5] Psychologists and educational policy researchers are urged to turn attention to the later stages of career development where women's career aspirations often plummet and where women get stuck or drop out of STEM all together.[6] This paper presents the preliminary results of a qualitative research project, with an analysis that focused particularly on isolating aspects that these female STEM doctoral students experienced during one academic year.

The graduate school period along the academic science and engineering career pathway has received little research attention despite alarmingly high attrition rates[e.g. 7, 8 , 9] that are strongly associated with gender and academic discipline.[8] Women who leave graduate school before receiving a graduate degree either leave STEM altogether or enter lower-status STEM positions, moves that contribute to gender segregation in the STEM labor force. Without the PhD, women are generally not eligible for the research and development positions that are in high demand and that are required for the U.S. to maintain its science and technology strengths.[4] Therefore, characterizing the experiences of women in STEM graduate programs that may increase the risk of their dropping out or dropping down is vital for planning ways of promoting retention and successful degree completion.

The background characteristics of students (such as grades and grade point average) have not proven to be helpful in predicting student persistence in graduate school.[10] Claims that women do not persist in STEM because of innate or inferior abilities are unfounded. [6, 11 for review] Researchers have turned attention to the role of the department and academic environment in the high attrition rates of doctoral students.[e.g. 12, 13]

*Isolation in graduate school*

The limited literature on the graduate student experience depicts an academic and social climate that is at best contradictory to female socialization, and at worst discriminatory, isolating, and hostile,[e.g. 12, 14, 15] much like the type of discouraging and dismissive undergraduate climate famously illustrated by Hall and Sandler in 1982.[16] Hall and Sandler (1982) coined the term "chilly climate" to describe such academic environments.[16]

One aspect of the "chilly climate" in graduate school we focused on is the common experience of social and professional isolation, a factor implicated in student attrition.[e.g. 12, 17, 18, 19] Doctoral programs in the United States have been criticized for their inherently isolating structure; [20] the culture of science and engineering, and particularly in environments dominated by men, has been found to be particularly isolating for women.[21] Women in STEM are often excluded from professional or social events [e.g. 12] and are less likely to collaborate with their advisors in research.[22, 23]

Such exclusion is not necessarily intentional or explicitly discriminatory. As clarified by Crosby (2007), group members (men, in this instance) naturally gravitate towards identifiable and similar individuals ("in-group members:" other men), thereby unintentionally ignoring or leaving out members of the "out group."[24] In male-dominated disciplines like the physical sciences and engineering, women are the minority or "out group," and are therefore at a higher risk for exclusion. According to the theory of the "null environment," [25, 26] women are disadvantaged if advisors and others do not invest in their career development as much as their male protégés. On the other hand, women may stand out and receive more attention in male-dominated fields. Ironically, one longitudinal study found that female faculty members were often asked to serve on committees to increase women in the field, which pulled them away from collaboration projects.[27]

Women with "multiple marginal identities," including women of color, non-heterosexual women, women with disabilities, and nontraditional students may be especially vulnerable to the experience of "chilly" climates and isolation.[e.g. 28] For example, lower income or physically handicapped women might be unable to participate in departmental social events even if invited. Women with children may not have the time or interest to socialize outside of school.

Whether intentional or unintentional, exclusion and isolation mean fewer opportunities to network, collaborate, bond with colleagues, and become socialized into science, engineering and academia. As conceptualized by Coleman (1988), isolated students are excluded from the "information flow" occurring between colleagues and will build less "social capital," as a result.[3] Social capital consists of knowledge about expectations and norms and is essential to student persistence and success.[3] For example, access to "social capital" might help successfully

integrate engineering students in the racial minority who might otherwise be at higher risk of dropping out.[29,30] Student integration is especially important for new doctoral students as they are confronted with a set of expectations and norms very different from what they might be used to.[20] For example, doctoral students must learn to become independent, productive scholars and develop a network of professional supports; grades are no longer the primary measure of success. Unfortunately, the discipline of engineering is described as an "individualistic weed-out culture."[30] This type of competitive, hostile environment is thought to foster isolation.[9]

Ali and Kohun (2007) advocate for more research attention to the "emotional" aspects of isolation as related to student attrition.[17] For example, severe social isolation is related to depression.[31] Some of the more subtle effects of isolation in graduate school might include an impact on students' perceptions of competency, or levels of confidence. According to Beeler's (1991) model, successful graduate students progress through predictable stages of awareness with respect to competencies.[32] They start graduate school highly confident yet ignorant ("unconsciously incompetent"), but quickly become aware of how much they still have to learn about their new field ("consciously incompetent"). Students might continue to feel doubtful of their abilities while developing competencies ("unconsciously competent") but, ideally, will regain confidence ("consciously competent") prior to completing graduate school. Beeler (1991) hypothesized that social isolation is a barrier to successful movement along these stages of awareness.[32] Socially isolated students are unable to compare their experiences and developing competencies due to the sheer lack of interaction with others. Students do not know where they stand if they cannot talk to others about their experiences and might remain stuck in the "consciously incompetent" stage, Beeler (1991) predicts.[32] Etzkowitz et al. (2000) also theorize that isolation and a lack of adequate mentoring in "chilly" academic climates relates to self-blame and decreased confidence in abilities.[12] Fabert and Bernstein's (2009) study with female non-completers of doctoral programs in STEM also found that women's confidence eroded over the course of graduate school, especially when women had limited opportunities to compare their graduate school experiences.[33]

To summarize, literature suggests that social integration is important for student success and persistence, but women and other minorities may be especially vulnerable to the experience of isolation in male-dominated graduate school programs. Beyond this broad stroke, little can be concluded about how isolation and other aspects of the "chilly climate" are experienced and negotiated, or how they are related to important career decisions. While some researchers have explored aspects of the "chilly climate" for women in the undergraduate classroom or workplaces, what has been lacking is longitudinal, systematic research on women's graduate student experiences. Explanations of isolation and other aspects of the "chilly climate" have to date been highly abstract and theoretical.

Over the past several years, researchers with the *Career*WISE program, supported by the National Science Foundation, have worked to understand and develop interventions to help mitigate common discouragers for women enrolled in doctoral programs in STEM. *Career*WISE focus groups of graduate student women [33] and interviews with non-completers reflecting on their graduate student experiences [34] revealed that dissatisfaction with the departmental climate (such as experiences with isolation) was one of several major discouragers reported by the participants.

This paper presents preliminary results of a qualitative, longitudinal Career*WISE* research study of female students enrolled in science and engineering doctoral programs across the United States. Data were collected via online blog entries about day-to-day events and exchanges recorded by participants on a biweekly basis. A small sample of participants was also interviewed on a biweekly basis and asked to provide similar information. Consistent with a symbolic interactionist framework,[35] data collection and data analysis emphasized the situational level or "incident" as the unit of analysis. "Incidents" (events and interactions occurring in the lives of the participants) were analyzed for their associated meanings and consequent actions taken by the participants. We were particularly interested in the meanings women formed of interactions with their advisors and others within the program and discipline, as well as the influence of broader institutional and cultural elements related to gender (e.g. sexual harassment grievances procedures, family friendly policies) on their decisions to persist or not in STEM doctoral studies.

**Methodology**

This analysis focuses on the qualitative component of a larger set of multi-method data looking at self-efficacy, resilience, problem-based coping, satisfaction with program, and intention to complete the degree. The study was part of a larger research project designed to investigate the effects of an online career intervention developed over the past four years by the *Career*WISE research team.

*Participants.* Women enrolled in public and private research universities across the United States were recruited from traditionally male-dominated departments, such as departments of chemical engineering, civil engineering, electrical engineering, material science, mechanical engineering, computer science, applied physics, applied mathematics, physics, astronomy, mathematics, chemistry, and geology. This qualitative, longitudinal study had two distinct data collection procedures: collecting incident reports and conducting open-ended interviews. Twenty-four participants completed the weekly "incident reports," and three women participated in the open-ended bi- weekly interviews over the course of the academic school year (eight months). Sixteen participants were enrolled in physical science programs, ten participants were enrolled in engineering programs, and two participants were pursuing degrees in mathematics. Additional demographic information is not included in this report in order to protect the confidentiality of the participants.

*Procedure.* Each of the three women participating in the biweekly interviews was considered a separate case to be understood as a whole and also in context with other participants.[36] Interviews were conducted following cognitive interviewing and ethnographic interview techniques. Spradley's (1979) ethnographic interviewing techniques position participants as active, meaning-making agents of their lives and life narratives.[1] Interview questions included "grand" and "mini-tour" questions, eliciting the chronology of events (e.g. "What happened prior to this event?" "What happened next?" "How did you react?"), and focusing on recent incidents to elicit as much rich, accurate detail as possible and emphasize actions and events (as opposed to interpretations or judgments). Recommendations by Charmaz (2006) for building rapport, maintaining the dignity of the participants, and ensuring a positive interviewing experience for

the participants (e.g., appropriate, timely, probing techniques, validating the perspectives of the participants) were also considered during the interviews.[37] To supplement the interviews, participants were also able to submit on-line journal entries to a secure, password-protected website. All interviews were transcribed professionally and stored in a secure electronic location. Special care was taken to ensure the confidentiality of the participants, including assigning all participants code names while storing and analyzing the data.

The other 24 participants were asked to submit an on-line journal entry to a secure, password-protected website every other week over the course of approximately one academic year (eight months). In the journal entries, called "Incident Reports," the participants described –in concrete and specific terms - a recent incident that occurred to them. Participants were provided an "Incident Catalog " consisting of 20 examples of specific things that *can happen*, such as potentially discouraging incidents ("a piece of apparatus I needed to do my research broke and set me back at least a semester") and incidents that might bolster a student's confidence ("my advisor announced to the whole lab that I had made a breakthrough in my research"). In addition to the Incident Catalog, we instructed participants to describe the incidents by observing closely and reporting in detail what specifically was said and done, who else was in the room, what happened that led up to the incident, what happened afterwards, how participants reacted, how they thought it through and made sense of it, and whether anything changed as a result. The instructions were similar to the interview protocol used in the case studies.

*Data Analysis.* Analysis of the interview transcripts and Internet blogs followed grounded theory techniques as defined by Glaser and Strauss (1967), Strauss and Corbin (1990) and elaborated by Charmaz (2006).[2, 38, 37] This methodology allowed us to provide an account of a year in the life of our participants rooted in their lived experiences. Another benefit to using grounded theory techniques is that they can help provide a fresh look at an "old" problem.[39] Researchers used different software programs to manage and organize the data, including Atlas.ti, NVivo8, Microsoft Word, and HyperResearch.

The first round of analysis consisted of assigning line-by-line "open codes" to units of data reflecting the action and processes occurring in the data and avoiding evaluative, analytical assignments. The researchers kept open codes close to the data and to avoid high levels of abstraction at this level of data analysis. Coders were also instructed to distinguish between emic (how participants view their world, also known as "in vivo" codes) and etic (codes from theory or the researcher's thinking) categories.

Constant comparison[2] techniques were used to sort through the open codes. In constant comparison, segments of data with the same code were compared to one another in order to ensure that the code belongs to the assigned category. Constant comparison was used to compare initial codes and associated quotes to come up with "focused codes," or code names for larger segments of data. Memos and theoretical codes were used to help understand the themes in the data and start to consider how they relate to one another. Codes (and their associated quotes) were added or removed from different families as necessary to improve fit. Some codes were assigned to more than one family. These family groupings started with temporary labels, which were modified as necessary to better describe the data contained in the different family groupings. If there were very few quotes in any given code (and each code was also a part of

some other code family), this code grouping was taken out. The focused codes of one transcript were constantly compared to other transcripts in order to identify common categories or themes. When there seemed to be similar categories or themes occurring in different transcripts, these similar family codes were printed out and their associated initial codes and quotes were compared.

Memos were used as a way to make the subjective coding process more transparent. Charmaz (2006) recommends using multi-purpose, informal "memos" throughout the research process. Memos are described as unofficial, spontaneous, personal notes made while coding and analyzing the data in order to keep track of initial hunches about the data, flag the need for follow up, identify inconsistencies and unanswered questions, and document personal reactions to the data.[37] Memo names became focused or theoretical codes if, through the use of constant comparison, it was determined that this was a frequent, salient theme occurring in the narrative and/or could be used to help explain the relationship between categories. Memos were also used informally to explain or remind the researcher about a particular code or code family, and to document the process of moving from focused codes to labeling theoretical codes, which reflected emerging themes about what was happening in the data and how different focused codes were related to each other. Ultimately, the purpose of this data analysis process is to build a theoretical model of what was emerging from the data (e.g., what happens that leads women to change or curb their career aspirations). Narrative and case study methods were used to reintegrate the data as a whole, to "recontextualize" the data into a narrative of the case.

In naturalistic inquiry such as this study, the criteria for validity are addressed by responding to questions of applicability, consistency and fidelity. Lincoln and Guba's (1986) terms of credibility are used to demonstrate internal validity and transferability to reflect external validity.[40] The criteria of credibility were met through long-term, in-depth contact with participants, cross-checking of data by the researchers through discussing emerging themes, and looking for data points that disconfirm developing themes.[40] Transferability of the themes can be seen in the thick descriptions developed using the context of incidents.[41]

**Results**

As hoped, preliminary data analysis has provided us with specific details on the graduate school experience for women in STEM doctoral programs, including a new take on the properties of isolation. A common experience among participants in both components of the study was "feeling different" from an implied institutional norm. Students sometimes self-isolated in order to meet a perceived need to present themselves as capable and as "fitting in" with an institutional norm implied in competitive departmental climates. Reliance on remote communication provided by advanced technology as well as the process of academic specialization seems to be associated with (and exacerbate) the experience of isolation. Especially when socially isolated, discouraging incidents led students to question their competence, their "fit" in the institution and by association the profession, and future aspirations.

*Feeling Different from the "Typical Student"*

Academically, the women in our study wanted to be viewed foremost as individuals with a developing science identity, irrespective of their gender. However, not surprisingly, some of the

barriers women confronted seemed to be due to their saliency as the "token" minority female student:

> My boss and the program in general are trying to recruit women, but how they go about it is getting difficult to handle. I am the only female graduate student in my group, have been told that I have to recruit women. No one else has been told to do this, just me. I am given the duty to take any female recruits out to lunch and entertain them…and while I'm flattered he trusts me enough to recruit students, I am only asked to help when it is a FEMALE recruit. The same thing happens when we host speakers. There are a group of favorite guys that go out to eat with the speakers and the only time I ever get asked is if it is a FEMALE speaker. It's a little insulting to be paraded around as the token female.
>
> The lab director has been good at reprimanding guys in the past for engaging in sexual harassment behavior like sending around inappropriate pictures of themselves or wearing shirts with derogatory terms for women on them. But at the same time he has had a number of private conversations with myself and the one other female in my program to ask if something offends us. While it is nice to know that he is concerned, if we are, then EVERYONE in that group would know that one of us said it since we are the only females in the lab.

One of the women told about a friend in her program who faced uncomfortable stereotypes, not by her advisor, but by another faculty who presumed her relationship with her advisor was of a sexual nature:

> She has a really good, healthy relationship with her advisor and they are always in each other's offices talking about science. In their office is another professor who is one of those old-school, good old boys, and he's completely your typical sexual harassment pig. He really is. …My friend and her advisor, every time he would walk by their office, he'd see them talking and he would say, "You know guys you spend an awful lot of time together, this is how rumors get started." He kept saying this over and over, every time he would walk by their office. She's worried that her advisor's going to back off from her because people might think something or because this guy keeps saying inappropriate comments.

Such incidents served as constant reminders to participants that they stood out and were perceived differently as women in male-dominated departments.

In addition to their minority status as women, our participants also differed from the typical STEM student profile as primary caregivers, as the only domestic or international student, as an ethnic minority, and/or as a nontraditionally aged student. While there was no explicit standard for a "typical" graduate student in science and engineering fields, when compared to the characteristic actions and lifestyle of the other students, the women in the study felt positioned outside of an implied norm:

> There's definitely a separateness. Not only because of my age, but my situation and the fact that I'm not only a year ahead of them, but I had been in a school already before I transferred for this advisor. I had three years, they've had one. It's a pretty big gap in many different ways, socially, economically, chronologically, so there's a lot of different separations between us.

In situations where women were involved in other roles aside from being a student, the contrast with the "typical student" was more pronounced. Not wanting to socialize after hours with other students, having limited time due to care-giving responsibilities, or simply wanting to spend time with their family set them apart from other students. Women experienced these differences as lost social opportunities, leading to a greater sense of isolation from their peers in the department:

> They're very young. They go out and celebrate later or go do something else. I do exactly what I want to do which is go home to be with my family. There is just a completely different mindset on what our social lives are like. They live in apartments close to school and they walk to work. I drive 25 miles after dropping the kids off at grandparent's house or school. It's a very different world. I have to come home and work and wait until the kids fall asleep to work and get up early to work and squeeze it in, in between taking care of everything else. There's obviously apparent differences between me and the rest of the students, that makes it quite obvious I'm not going to participate in a lot of what they're doing together.

In some programs there was an implied standard of spending very long hours in the laboratories set by the male and often international students. A woman student who wanted some balance with life activities outside of work did not want to conform to what she saw as unrealistic expectations:

> I feel like domestic students [such as her] don't really want to join a group that contains only international students because they just don't care if they work all the time in general. Well, just like the fact that my group was all there on a holiday and most other people—I mean the building was pretty empty. There were other people there but not that many. I don't really care—I mean I don't care if I'm in the lab less than other people really but…I don't know...

Academic activities and social activities were often paired, as in scheduling lab group meetings on Friday afternoons then heading off for happy hour. By not able or wanting to participate in the social gatherings, women felt less membership in the group, as stated by the following three women:

> They have beer hour every Friday at 5:00. Well, that's completely out of the question for me, so I lose that social aspect.

> Yesterday, I was walking with another student in the hallway and he asked me how my evening was, which I thought was kind of strange. I said fine and then asked how his was. He replied that he had a "drinking meeting" with the all the guys in the lab, everyone except a new guy and our advisor. I did feel a bit left out, even though I wouldn't really want to join them, and it seemed like he really wanted to tell me that they went out.

> While I appreciate when I am asked (rarely) to join the all-male but me lab group, I say no. I hear how they talk about the women they meet and their other exploitations from happy hour and I don't want to subject myself to that environment.

The tacit positioning of work load expectations, scheduled meetings, attendance at conferences, and social events geared toward "typical" students exaggerated differences. This led to greater stereotyping of these women and, consequently, a greater sense of isolation in their departments.

*Managing Perceptions*

Some participants perceived that they were being held to double standards and encountered gender stereotypes related to their competence:

> If a woman falters in a presentation or technical conversation, people are more likely to write her off quickly and not give her the opportunity to recover. She is immediately written off as incompetent.

> Here's the problem, when a woman does act confident and knowledgeable, communicating things in a straightforward, blunt, "male-style" way, reactions are often negative. I've even felt this when communicating with one of my advisors; when I act confident, it seems to me that it makes him a little uncomfortable. I'm afraid that sometimes in presentations when I answer questions in a straightforward, confident manner that I come off as bossy, or bitchy. A woman who confidently argues her point is somehow less likable than a man who does the same. I KNOW this is the reaction that some people have when a woman presenter adopts a leading/commanding role, because they have expressed it to me. It's like when a guy disagrees with a guy, it's fine for them to talk it out, but sometimes when they question a woman, they expect her to back down more or concede something and if she doesn't, they feel like she's just on a power trip or not listening to them.

The perception of even subtle stereotypes pose threatening environmental conditions for women in traditionally male dominated fields.[42] When the women already felt different or set apart from other students because of gender, family status, or age, they were particularly vigilant to monitor how others perceive them. Actions viewed as overly competitive were feared to foster animosity between the women and the other students. One of the women interviewed described taking care to not act too presumptuous and feeling uncomfortable with the competitiveness she felt her advisor fostered among the students. She recalled an incident at a group meeting where she asked questions to help a student elaborate on a work he was having difficulty presenting. She wanted to help the other student, but when her advisor praised her and criticized the other student, she feared the other students viewed her as vindictive:

> My advisor just said in front of everyone, "Why is Karen having to give your presentation for you? How come Karen knows this and you don't? Why is she having to do this?" It was just like, well, don't do that to the guy. I felt terrible. That wasn't my intention. I'm not that kind of person. I'm not a competitive person, and I didn't want him to feel bad… The other students felt like it wasn't a nice thing to do. They took it out— they thought that I enjoyed that. My advisor was trying to foster this competitiveness. It's not what I was trying to do. I was trying to [help the student] get across the point of the paper… That's where the walls started being built up.

This perceived need to appear agreeable, "normal," and/or capable sometimes trumped the desire to seek support from advisors and other students. For example, one participant was certain that she was the least competent student in an advanced biology class, but refused to run this

assumption by her classmates in fear of looking "stupid:"

> [The professor] makes comments like, "If you guys don't speak up, it's just not good for you as graduate students," and comments like that make you feel really bad. It's just really making me, it's just lowering my self-esteem because I already feel really bad about this course because I feel like I'm an idiot, and I hate feeling stupid. I really hate it. I hate being in a class where I'm the stupidest one or the most one that doesn't understand anything. I'm just like, "Oh, my, God, I don't know what to do."…I'd rather not know than find out that everybody is doing so well, and I'm the only one that's not.

This participant would wait for an invitation from her advisor to ask questions, express concerns, or request assistance, also because she did not want to appear incompetent:

> Sometimes he assigns these really difficult tasks and I start to wonder, how am I going to do this? This is really hard, and sometimes I feel like I need help, but I hesitate to ask him because I feel like, you know I get scared, I am afraid he might think, you know, that I am not good enough or I am not capable of doing the job, so it's always like, you know, you need help but you can't exactly ask him outwardly, I don't know if I'm just being sensitive about it and it's just normal to ask, I just get very, I start to wonder if I am supposed to know how to do this stuff, is it supposed to be this challenging?

Other participants also alluded to a tendency for the women in their programs to keep quiet when uncertain about their ideas:

> I am beginning to realize that how I communicate as a female is a hindrance to me in my program. I am less confident unless I know EXACTLY what I'm talking about. It seems like the guys in my program are really good at making it sound like they know a lot. They are great at bullsh**ing about what we're studying or working on in the lab and many don't hesitate to offer up their opinions as fact. I don't do that at all and if I am not absolutely certain of something, I'll say so. I wish this was just a personality trait, but when I asked a few of my fellow female students, they feel exactly the same way. We just don't inherently have the machismo or something that the guys do.

Keeping quiet may be one impression management strategy used to navigate a cut-throat culture [30] that penalizes intellectual risk taking. Unfortunately, this strategy is inherently self-isolating and might stifle collaboration among colleagues. It also might prevent students from shifting from the "unconsciously competent" to "consciously competent" stages of awareness.[32] Put simply, students will not be able to gain confidence in their own abilities if they are afraid of making mistakes.

*Working and Communicating Remotely*

Working and communicating remotely made it even easier for women to become isolated among colleagues, whether out of necessity or by choice. On the one hand, if not for "Skype" and conference calling devices, some of our participants might not have had the opportunity to pursue the PhD in the first place. Indeed, it has become increasingly possible for nontraditional students (e.g., parents, international students, students with full time jobs) to go to graduate school. Female students who have children may select specialties in part because of the chance

to work from home.[43] Of the participants in our study, one woman arranged her schedule to work from home part of the week so she could be more available to her young child. An international graduate student communicated with family and friends from her home country when in the US, or attended research team meetings and classes remotely when she was living with her family. Other students simply chose to work outside the office or lab when possible out of personal preference. Still others found that working remotely was the preference of their advisors or research team members.

Many participants felt lucky to have the ability to connect remotely with research team members and social supports. However, working remotely was not equal to face-to-face collaboration, and several drawbacks were associated with this mode of communication. First of all, students found that relying on distant correspondence was not as efficient and slowed research progress:

> When I was in (her home country) I was all on my own. I managed to get through it for my Masters but it wasn't easy to be honest. I did struggle a lot because sometimes I would get just stuck for like weeks and weeks and not be able to move forward because he (the student's advisor) can't really help me.

Working on campus was considered more advantageous to provide easy access to physical and human resources and can hasten degree process:

> Um, well, it's been quite interesting actually, it's a different experience than having to do all of the work remotely. Getting exposed to more expertise by the people here, and being on campus is definitely an advantage because I have access to resources that I haven't had before, just like the hardware and machines that I am currently operating. So overall I guess it has been a better experience.

> Because like a lot of the stuff we do is like practical work and you have these problems with these programs you're running or you know something. You're not getting output you're supposed to. Usually when he comes in we have a one on one meeting that's face to face, he can usually you know play around with my computer and like you know help me out on the spot.

Another drawback to e-mail communication is that it lends itself to miscommunication. The following excerpt from an Internet blog depicts confusion and frustration about the overreliance of her department on e-mailing:

> It seems like the only form of communication I have with others is through email. I spend so much time in the lab or reading that I rarely see people to have a conversation, unless it is on Skype or if I happen to see someone in the hall when coming or going and those are usually just grunts. Communication comes through responding to or sending out emails, and it is challenging to figure out the cues that people write. Sometimes my advisor sends really short responses and I can't tell if it is because they are angry, busy, or just don't care. I would like to be able to sit down face to face and meet with other students. It seems as if this only happens when I am at conferences. I can't wait until this is over.

When advisors also used remote communication to work, a reduced schedule of time on campus led to missed opportunities for the student to interact with advisors and other students:

> We're not in together a lot is one of the issues. With me working at home two days and those are the two days he comes in. He's got meetings until the afternoon on one of the days. Then we have our group meeting and then we have our department seminar. Then he's gone. Apparently one day he's not supposed to be in but he came in to talk to me and I wasn't there. He said, "I came in just to talk to you." I'm like okay, am I supposed to feel bad about that?

*Specialization in Research and Knowledge*

Due to the highly specialized nature of the physical equipment needed for certain types of research in science and engineering, our preliminary results indicate that the process of becoming an expert in these fields can also be an isolating, frustrating part of the graduate student experience. For example, one student spent half her time literally alone and isolated while working with scanning and x-ray equipment for her research. Only one person was allowed in this high- security lab at a time. Even in the "office" where other students would work, the discreteness of research roles and endeavors was emphasized. Colleagues were not considered part of a research "team," but rather as a group of students sharing a space: "…so we do have some kind of interaction, but it's just general stuff, not anything related to our work. Each one of us does specific research." As projects are highly specialized, students are often left to troubleshoot on their own:

> I mean the students that are here—sometimes when I get stuck on something and I ask them, they sometimes help me. Not always because it's not necessarily that they've done the same exact thing that I'm trying to do.

> If I could just talk to someone, someone who is an expert in this field, then I could very quickly, easily, and accurately figure out the meaning behind all my data. But obviously I can't do that, because I have to figure it out on my own, because this is academe. That, and there is no one here who does the new type of analysis I am doing.

Working with cutting-edge software can also present frustrations, as students are not even able to turn to the literature when facing technical issues. One student's new software program had hardly been reviewed as it had just been released and was highly specialized:

> It's still in development. The only documentation I found online is not complete and I don't know who to ask... There was a problem with the segmentation. It doesn't say how you're supposed to use it. The program is just there. There is no help. I'm just playing around with it trying to click everywhere. Just randomly guessing trying to figure out how it works. I looked through the online materials and it just has pictures of what it's supposed to look like. It doesn't say the steps that you should follow.

Doctoral studies are designed for students to develop a niche within their fields of research. Ideally, increased specialization and expertise are accompanied by an increased sense of competency and belonging. However, these results suggest that academic isolation can increase along with research expertise over the course of graduate school.

**Conclusion and Discussion**

In sum, the participants in our study often could not escape reminders of how they are different

from the typical STEM doctoral student, not only as women but often also as nontraditional students. The tacit positioning of work load expectations, scheduled meetings, attendance at conferences, and social events geared toward "typical" students exaggerated differences. This led to greater stereotyping of these women. Consistent with the literature in which science and engineering departments are cast as "chilly" for women, participants felt that their capabilities were scrutinized highly and unfairly. Choosing to limit interaction with others, made easier by remote technology, is one strategy that women use to navigate the competitive climates of their fields. Our preliminary results also show that this sense of isolation might increase as women advance in their doctoral studies and increase their expertise.

These results are consistent with research and theories on the role of gender stereotyping and "stereotype threat." [44, 45, 46] Valian (1998, 1999) has explained how gender schemas (ideas and assumptions about what it means to be a man or a woman) play a role in the devaluation of women's contributions in science compared to men.[45, 46] Stereotype threat occurs when minorities fear that if they exhibit a behavior consistent with stereotypes about their social group they will confirm these stereotypes.[45] This fear results in anxiety and underperformance, ultimately becoming a self-fulfilling prophecy. Stereotype threat has been known to occur for women, especially in situations in which they are the token minority,[47,48] such as in science and engineering classrooms. The results of Etzkowitz et al. (2000) and Sonnert and Holton (1995), which also suggested that the contributions of budding female scientists are often devalued, eroding women's confidence in their work, support Valian's gender schema theory.[12,15]

Our preliminary results present a new take on how stereotype threat may be managed by graduate students. Women may be more hesitant to share ideas and take risks in climates that are inherently competitive and hostile, and in which they are confronted by gender stereotypes regarding their intrinsic capabilities in the field. Such self-isolating behavior (assisted by a culture of remote communication) might prevent successful movement along stages of awareness of competencies in graduate school.[32] Again, in Beeler's (1991) model, social isolation is a barrier to successful movement because students are unable to compare their experiences and developing competencies due to the sheer lack of interaction with others.[32] Students don't know where they stand if they cannot talk to others' about their experiences and might remain stuck in the "consciously incompetent" (or, for that matter, "unconsciously competent") stage of awareness. Additional research is needed to better understand self-isolation as a strategy used by female, minority, and nontraditional students in an advanced world of technology.

These results serve as a reminder of the need for faculty and administrators to take an active role in student integration and to consider the needs and preferences of all types of students, especially when pairing academic and social events. Although the use of e-mail and Skype may provide opportunities to accommodate nontraditional student schedules, in-person interaction appears to be preferable when possible in order to help protect students against the damaging effects of isolation and to help promote graduate student retention.

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