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"If I Wear High Heels, I'm Gonna Be Judged": An Exploration of Women Doctoral Students' Experiences in STEM Conference Spaces

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ABSTRACT

A gender gap in science, technology, engineering, and mathematics (STEM) fields persists despite the growing acknowledgment of the inequities women face. One pathway into STEM careers is attending academic conferences, where doctoral students can engage with the wider community in their field. This study shares the experiences of women doctoral students at academic conferences, using a gender and science identity lens. We conducted semi-structured interviews with 23 women doctoral students in STEM programs at a university in New Zealand. Our findings show that participants experienced conferences as gendered spaces, and these experiences affected the development of their science identity in multiple ways. Our research highlights a continued need to combat gender inequities in higher education and reimagine conferences to be more inclusive. Combatting gender bias in such spaces requires changing organisational practices to enable women's science identities to flourish.

Keywords: gender identity; science identity, STEM, conferences, doctoral students

A gender gap in science, technology, engineering, and mathematics (STEM) fields persists internationally despite the growing acknowledgement of the structural barriers hindering women from building careers in STEM fields (Master & Meltzoff, 2016; OECD, 2011; van Langen & Dekkers, 2005). Prior research has documented how sociocultural beliefs, institutional inequities, and stereotypes about women's roles and abilities contribute to the persistence of this

gap throughout K-12 education, its exacerbation in higher education and into STEM careers (Ceci et al, 2009; Master & Meltzoff, 2016).

Women are less likely than men to earn STEM degrees from higher education institutions and to work in STEM careers (OECD, 2015). Only 25% of mathematics and engineering degrees on average across OECD countries are awarded to women (OECD, 2011; Mostafa, 2019). In the US, women's participation in STEM fields decreases steadily from undergraduate to postgraduate through to doctoral level study; this disproportionality has remained unchanged over the last decades (Booker, 2018) and is particularly true of women of colour (Arroyo, 2017; McGee & Bentley, 2017). In 2015, only 2% of practicing STEM scientists and engineers in the US were Black women (National Science Foundation, 2015); this severe underrepresentation is linked to issues Black women face early in the STEM career pipeline (McGee & Bentley, 2017).

In New Zealand, the setting for this study, Tertiary Education Commission (2020) data reveal that less than a third of all students working towards a STEM-related qualification are women; an even smaller number of women are enrolled in postgraduate programs. Further, New Zealand's National Government Communications Security Bureau (2018) reports that women make up only 20% of professionals in STEM-related roles. Of this already small percentage, indigenous Māori and Pasifika women only make up a small fraction.

The current study focuses on a relatively understudied but distinct time in women's STEM career development, their doctorate. More specifically, we focus our inquiry on academic conferences, intended to socialize doctoral students into the wider academic community. Conference attendance provides doctoral students with an opportunity to learn about the latest research in their field and receive feedback on their own research from senior international researchers in the field. Academic conferences enable doctoral students as newcomers to participate in activities that signify their readiness to enter the field (Booker, 2018; Chapman et al., 2009). Conferences can also provide opportunities to form national and international networks for collaborative research projects, for employment, and to publish research findings (Sabharwal et al., 2020; Wang et al., 2017). Further, incorporating their learning from conferences into their professional practice can become a key factor in the continuing professional development expected of scholars and practitioners (Chapman et al., 2009; Günbey & Karakütük, 2024). Positive experiences at academic conferences can contribute to building their confidence and ascertaining their science identity.

Women are more likely to persist in STEM fields if they have confidence in their analytic abilities, self-efficacy related to their capacity to be successful in their chosen field, and a strong science identity (Booker, 2018; Chemers et al., 2011; Soldner et al., 2012). Positive conference experiences can propel women into STEM careers; conversely, an accumulation of negative experiences can push women out (Yang et al., 2022). However, despite the importance of

academic conferences in women doctoral students' academic and professional development, there is a paucity of research looking specifically at the conference experiences of women doctoral students in STEM fields.

Academic Conferences as Gendered Spaces

Prior research has identified conferences as gendered spaces (Biggs, 2018; Eden, 2016; Jones et al., 2014; Sabharwal et al., 2020; Settles & O'Connor, 2014; Walters, 2018) and noted numerous obstacles women face compared to men, from greater difficulties accessing conferences to negative experiences when attending and presenting at conferences (Case & Richley, 2014; Handforth, 2022; Mwenda, 2010; Richman et al., 2011).

Barriers to attending conferences often stem from differential access to resources or opportunities at their host universities. For example, Ampaw and Jager (2011) found that men doctoral students tend to have more opportunities to serve as research assistants during their doctorate, providing them with more opportunities to build research networks, and secure funding to attend conferences. Furthermore, women doctoral students often name family responsibilities as reasons for not being able to attend, while men doctoral students do not note such responsibilities as an obstacle (Case & Richley, 2014; Cidlinska, 2018; De Welde & Laursen, 2011). Women doctoral students also reported more financial barriers than men to attending conferences (Mwenda, 2010).

As a result, women doctoral students are less likely to attend conferences. Further, a 1992 survey of 298 women African American graduate and professional students found that though 80% had attended conferences, only 29% had presented a paper at a conference (Smith & Davidson, 1992). This inequity in participation has persisted over the decades. A study of women's participation in 56 academic conferences in Israel found that men's participation in conferences was three times that of women (Eden, 2016). A New Zealand Survey of over 500 early career academics showed that women were less likely to attend conferences, especially international ones (Timperley et al., 2020). Other studies have documented inequity in the placement of women in shorter presentation slots than men (Jones et al., 2014) and in fewer noteworthy roles such as keynote speakers and conference committee chairs (Eden, 2016; Walters, 2018).

When attending conferences, women describe men-dominant conference environments. These include the exclusion of women's perspectives in content, materials, or in the organization of sessions or the conference itself with, for example, masculine social agendas and all-male panels (Eden, 2016; Janz & Pyke, 2000). Further, male participants' communication and behavior at conferences have reportedly tainted the conference experiences of women academics. Reports range from the exclusion of women from discussions and Old Boys' Clubs' activities to discrimination through sexist remarks, patronizing

comments, off-colored jokes, to inappropriate behavior and harassment (Flores, 2020; Jackson, 2019). Such conference environments tend to encourage women to retreat as they are missing women role models or peers and feel uncomfortable engaging with male conference attendants (Hinsley et al., 2017). These studies paint a bleak picture of women's academics experiences at conference. Our research adds to the literature by offering the perspectives of those just entering the field, that is women doctoral students. We hypothesize that biased conference experiences would impact negatively on women PhD students' academic identity development and motivation to stay in the field. Although gender bias has certainly become more openly acknowledged in recent years, it nonetheless persists, with "the slow drumbeat of being underappreciated, feeling uncomfortable, and encountering roadblocks along the path to success" (Urry, 2005, p. B04) becoming internalized, eroding self-confidence and reinforcing to women that they do not belong in science.

Theoretical Frameworks: Science Identity Development and Gender

We explore women doctoral students' conference experiences using a gender and science identity development lens. We identify gender as a socially constructed concept that is pervasive, largely unconsciously applied, and embedded in structures, practices, and discourses. Gender is embedded in academic environments such as conference spaces and the interactions of people within these spaces. The conceptions of gender, and the actions that confirm and sustain them, influence and interact with one's identity, for example, one's identity as a researcher or a scientist (Ridgeway & Kricheli-Katz, 2013). Identity formation is not an isolated activity, but a social endeavor that is influenced by the relevant community of practice (Wenger, 1998) and requires necessary supports to develop this identity (Rockinson-Szapkiw et al., 2017). As Xu (2021) notes, "researcher identity is a relational and dynamic concept, which must be understood in relation to the participants as agents and the structure in which their agency enacts" (p. 7). Conference spaces provide one such structure to exercise agency as emerging scientists.

Gendered actions and interactions in doctoral students' communities of practice are often based on societal views and perceptions of what constitutes femininity and masculinity (Lorber, 1994). Societal gender stereotypes are also reflected in perceptions of societal roles and professions. Common stereotypes that exist around science and scientists relate to 'cultural fit' ('science is for men') and 'ability' ('men have more ability'). These stereotypes can be pervasive in both subtle and overt ways in verbal and behavioral interactions. Students learn and internalize normative behaviors, such as the accepted practices, behavior, and styles of communication, as they become part of a community of scientists through the process of socialization, for example at conferences. Hence, we examine women doctoral students' experiences of participating in and presenting at conferences in typically men-dominated STEM fields.

Our specific interest was in how potentially gendered conference interactions impact the science identity development of these doctoral students. Doctoral students are in a critical stage in the development of their careers and academic identities. We draw on Carlone and Johnson's (2007) model of science identity development which focused on women of color in science, a framework whose constructs we feel are appropriate for STEM fields in general. Their model includes three interrelated and overlapping dimensions: *competence, performance, and recognition*. These dimensions of identity are developed in interaction with one's science community, in this case, at academic conferences.

Competence presents one's level of knowledge and understanding of science content, which is often less overt or visible than the other dimensions (Carlone & Johnson, 2007). The competence dimension interrelates with the dimension of performance, as performance is the public act of using one's competence in the field. In this research, we distinguish between these two domains by coding experiences related to students' own or others' identification of their skill and knowledge as 'competence' and their experience presenting a paper or poster as 'performance'.

Performance entails the social performances of relevant scientific practices. Previous research has conceptualized performance by examining assessment data or course completion (e.g., Chen et al., 2021), however this conceptualization has been critiqued by questioning whether "the achievements of men are the most appropriate standard; individual experiences and students' identities are undervalued" (Traxler et al., 2016, p. 020114). Thus, in this research, conference performance is used as the proxy for this domain.

Recognition in Carlone and Johnson's (2007) model refers to the recognition of oneself and by meaningful others as a 'science person'. Recognition seems an especially relevant dimension in women's development of science identity, because as Avraamidou (2020) notes, "science has traditionally been an elitist world from which certain groups [such as women] are excluded" (p. 332). Rodriguez et al. (2017), in a study of Latina undergraduate STEM majors, found that recognition from within the disciplinary community, in this case, faculty members and peers, was especially important. Carlone and Johnson (2007) note that recognition seems to be a particular barrier to women's science identity development as it is dependent on the interaction with an audience and a community that is typically men-dominated. Thus, women who do not experience recognition, experience misrecognition or have negative experiences when seeking recognition related to societal stereotypes, can suffer psychological harm (Iser & Zalta 2013). Recognition might occur through formal interactions or informal networking events, in contrast to identification of their 'competence' through explicit praise or a specific 'performance' at a conference.

A number of previous studies have adopted Carlone and Johnson's (2007) model to investigate women's development of science identities. However, these have often focused on the doctoral journey in general or the

transition into early career academics. Prior research using this framework has also tended to adapt the dimensions to their specific case study context (see, Espinosa, 2011; Hazari et al., 2013; Herrera et al., 2012). We extend this prior research by examining the following research questions:

(1) How do women doctoral students in STEM programmes feel that their gender influences their academic conference experiences?
(2) What is the relationship between women doctoral students' conference experiences and their science identity development?
(3) What do women doctoral students feel can be done to improve gender equity in STEM academic conference spaces?

Methods

The study design draws from a constructivist theoretical paradigm in which knowledge is constructed through participants' experiences (Merriam & Tisdell, 2015). As such, we gathered detailed descriptions of the academic conference experiences of women doctoral students in STEM fields to enable their rich narratives to answer our research questions. Participants were recruited by sending out email invitations to all doctoral students in STEM fields identified via the doctoral student directory at a New Zealand university. Students were eligible to participate if they identified as a woman and had attended an academic conference, whether in person or via Zoom, as part of their doctoral studies. Twenty-three participants volunteered, ranging from first-year students to recent graduates. All participants were cis-gendered. They were from a range of STEM programs and included domestic New Zealand students and international students from a range of countries. The different backgrounds, stages of study, and nationalities of the participants provide a rich variety of experiences.

Data collection

The research team conducted semi-structured interviews, with follow-up prompts to collect rich data about participants' conference experiences (Patton, 2002). The interviews focused on participants' experiences with conference preparation, presenting their research, and attending formal and informal networking events at conferences. The interview protocols were developed by the research team based on a review of prior research and validated through expert advice (Dillman et al., 2014) from a professor with over twenty years' of experience mentoring women doctoral students in STEM. The interview protocol was further validated by the research team after reviewing the recording of the first interview and making final modifications to ensure the questions would elicit the information needed to answer the research questions (Willis, 2005). Transcripts of the interviews were transcribed by the research team.

Data Analysis

Thematic analysis of the interview transcripts was conducted (Braun & Clarke, 2006). Using a mix of deductive and inductive approaches, the research team created an initial broad code list based on the interview topics (Miles et al.,

2018). Two members of the research team conducted a pilot test of the broad code list in which they coded three of the transcripts and discussed discrepancies to ensure inter-rater reliability. A second coding iteration identified sub-themes within the broad codes. A third iteration coded excerpts according to Carlone and Johnson's (2007) three aspects of science identity development: recognition, competence, and performance, and then organized coded excerpts into sub-themes to capture the perceived role of gender in participants' conference experiences.

Findings

Our findings revealed that women doctoral students experienced conferences as gendered spaces (RQ1), which shaped their science identity development along the dimensions of recognition, competence, and performance (RQ2). Participants offered a range of ideas to improve gender equity in STEM academic conference spaces (RQ3).

Women Doctoral Students' Experiences at Conferences

While some participants reported a fairly equal gender distribution at the academic conferences they attended, others felt acutely aware of their gender in men-dominated conference spaces. The feeling of otherness reported by our participants included the conference environment broadly and the presentation environment specifically.

Conference Environment

Participants described pressure to counter gendered stereotypes and act more like a "man." Five participants spoke about the obstacle of "looking the part." As one participant said, "when I went to that first conference… I decided to wear a dress and then [worried], did I look too much like the secretary?" Another participant said, "If I wear high heels, I'm gonna be judged." Age differences between students and academics and intersectionality of race and gender were noted by some as additional factors that led to perceived unsupportive conference environments.

Safety attending evening events was also noted, including getting to and from events alone:

> My Airbnb was about 40 minutes' walk away…. So [I] had [to] weigh that up in my head and whether or not it would be safe at night-time to walk home…. Again, as a woman, unfortunately, we have to consider that.

As another participant highlighted, "In the social parts of the conference, where people are drinking and having fun and everything, I don't know if I'd feel 100% safe by myself." Our participants were acutely aware that conference events, formal or informal, that included alcohol can lead to uncomfortable – and potentially harmful – environments for women.

Presentation Environment

Conference spaces were described as "nerve-wracking" by nearly every interviewee. Participants reported experiences of gender imbalance and gender bias when presenting. One participant reported, "The older professors are almost exclusively men." Another said, "I don't think necessarily it's becoming more respected and inclusive. I think there's a kind of resentment coming up…. [There's] a lot of … lip service and a checkbox."

Participants noted hesitancy to engage in the question-and-answer portions of presentations for fear of "not wanting to ask too many questions, because that would just add to the stereotype of young women and research, not knowing what they're doing or being dependent upon senior or male researchers," as one participant put it. Another participant noted, "It was nerve-wracking trying to go and talk to [other presenters]. I felt that there was probably impostor syndrome creeping in." Although men also feel imposter syndrome, especially in the early stage of their careers, our participants felt this was more acute for women, as being new to academia was coupled with the internal misgivings of entering fields in which they are underrepresented and historically not in leadership roles. In the words of one participant, "If I'm a male scientist, I don't have to think about which conference will welcome me. They will all welcome me."

Women Doctoral Students' Science Identity Development at Conferences

Our findings showed that participants' conference experiences shaped their science identity development related to Carlone and Johnson's (2007) three dimensions of performance, recognition, and competence.

Performance

Barriers to developing a science identity through the performance dimension included logistical aspects such as the cost of attending conferences, arranging for childcare, and challenges with virtual conferences (e.g., learning the technology, time zone difference, lack of face-to-face contact), as well as anxiety around speaking a different language. As one participant noted, "That is especially difficult for international students whose first language is not English. I had to write down every word I will say, and practice again and again." The intersection of gender and language presents a barrier specific to international higher education students in New Zealand: while domestic conferences were reported as being more inclusive by many participants fluent in English, those who were learning English felt performance anxiety related to the language skills as well as their gender.

Although our participants had all presented posters or papers at academic conferences, they noted a gender imbalance in who presented keynote addresses. One participant noted, "When the conference program comes out, I would always look [and ask myself] 'Who are the keynote speakers? Are there any women? Are they even trying? Are there any indigenous women?'" The performance aspect at this highly visible level often seemed reserved for men. Further, women

who gave keynotes were perceived by our participants to be just as biased toward young women as the men:

> Other women who … [are] quite high up can sometimes …[think], 'I had to go through this experience. I had to go through being the only woman in the room. I had to learn to speak up and maximize myself. I had to try to prove that I wasn't a stereotypical woman to get here. Therefore, that's just how science is. That's how you should do it as well.' So, there is a sense … [that they] only succeeded as a woman because [they] became like the men.

This notion of women having to "prove" themselves through initiation rituals and imitation of men creates a space in which women doctoral students have to fight for acceptance rather than benefit from those who have gone before. Mentorship from senior women could benefit junior colleagues, but instead, many of our participants reported an expectation that they go through rites of passage to show they could be accepted in men-dominated conference spaces.

In addition, some participants felt that there was bias in the selection process for presentations generally, not just for keynote addresses. One participant hypothesized, "I think they're also looking at your supervisor…. I think because those people [reviewing the abstracts] … are often from that generation where women have been kind of significantly disadvantaged and spoken over… then maybe that has some kind of trickle-down." Another noted, "Your chances are already reduced by being a woman, then you're competing with other women for those fewer spots available." This sense of competition creates a disincentive to form collaborative relationships with other women in similar situations, as the perception that there are "quotas" for inclusion at conferences means needing to compete rather than cooperate to gain limited space on conference programs.

In contrast to these barriers, the performance dimension of our participants' science identity was enabled through a variety of mechanisms, both formal and informal. One such mechanism was scheduled social events, which alleviated the need to try to network informally. At a conference that one participant attended, she recalled that they had "events such as morning tea, brunch, and a welcome dinner… giving you more chances to meet new people." These social events provide opportunities to meet other doctoral students and academics in their field without the pressure to initiate meetings themselves. However, as noted earlier, evening events bore additional complications for women and a lack of personal safety in men-dominated spaces.

In addition, our participants reported the value of practicing their presentation in front of their supervisor(s) and/or peers before attending the conference so that they could revise their presentation. Trial presentation runs

that included practicing the question-and-answer portion were especially valued, alongside feedback on the presentation (tone of voice, speed) itself and the slide content. One participant described her supervisor's role in preparing her to present at a conference:

> She … said to me earlier, 'There'll be people who [will] … ask you things to try and trip you up. Here are … some points that might come up' and we worked out together what would essentially be the limitations section or the discussion section of your manuscript, making a note of those points that people were likely to ask about or criticize and then coming up with suitable responses for those.

Finally, participants noted that when they were able to attend conferences with others, they felt less invisible among the conference crowds. Attending with peers provided a way to feel more comfortable, even if the group predominantly consisted of men. As one participant reflected, "Among the students, I think there were only five [women] versus 20 men… [but being] with the group [meant] I wasn't completely alone, so that definitely felt better." If their supervisor was present, they could introduce them to others in their field. A participant described the benefit of her supervisor "knowing the really interesting people in our field, knowing them personally, and being able to go over and have a conversation … about how we could work together and bringing me into those conversations… [I] wouldn't really have had the opportunity if someone like her wasn't there." Access to more senior academics enabled our participants to develop the performance dimension of their science identity more readily than if they had to navigate conference spaces on their own.

Additionally, if the supervisor co-presented with the student, the supervisor was able to assist with any challenging questions. A student who felt nervous presenting in English noted the benefit of having her supervisor present, saying, "It was nice to have my supervisor there … [if a] question wasn't super clear, she seemed to understand what was being asked and would start off, and then I can add to it." Co-presenting enabled the development of the performance dimension, an aspect of science identity that was especially challenging if English was not their first language.

Recognition

The science identity dimension of recognition related to participants' perception of whether others judged their performance as credible. Feelings of recognition tended to come from external sources rather than internal self-confidence. Participants reported experiencing overt barriers to recognition including sexism, being spoken over, and having ideas dismissed by senior researchers. At times, participants were acutely aware of their gender, such as when one participant faced a "grumpy old statistician [who] asked me a question,

except it was more of a statement. He talked for a couple of minutes. Essentially, he said, 'What's the point of what you're doing?... Why are you bothering?'" In another case, a participant reported that at the end of a peer's presentation "one of the young American males stood up and basically re-appropriated my colleagues' work."

The science identity dimension of recognition was also evident in participants' perception of their ability to be seen at academic conferences. As one participant said, "You're looking at yourself through other people's eyes." Part of being seen was "looking the part," which often meant dressing in ways that would blend-in in men-dominated spaces. As one participant described:

> As someone who presents quite young, as a woman, I feel like I often have to try and sort of stand taller and speak deeper and try to look as if I'm sophisticated. I think quite deeply about what I'm gonna wear… so that those who have had more experience than myself will take what I have to say seriously.

This perception that they will not be taken seriously – not be seen – meant not presenting their authentic selves, whether in dress or voice. Their perceived need to perform an act at conferences presented a barrier to building their own science identities. Participants also felt they needed to act more "like a man" to be accepted as scientists: "I had to go through being the only woman in the room. I had to learn to speak up and maximize myself. I had to try to prove that I wasn't a stereotypical woman to get here." Another mused:

> A lot of women still hold themselves back. I think it's almost their own self-perception sometimes…. It is very heavily socialized, the construction of your identity and how women feel about themselves and, maybe the validation that people need.

As another participant said, "I don't wanna be just wearing a plain white shirt and plain black pants because that's not who [I am]. That's not who I want to present."

The need to dress "appropriately" was even more acute when attending conferences in conservative countries. One participant, who attended a conference in Kuala Lumpur, reported, "They have different beliefs about women…. They didn't want shoulders and knees out and things like that. So that was a bit more of a consideration about what kind of clothing to wear and being careful of local customs."

In contrast, participants identified a range of enablers to feeling recognized as a scientist, including being given positive feedback on presentations. Sometimes, feedback was tailored to the student as an emerging scholar, as noted by one participant's comment that "people knew I was new, so there were more suggestions than questions, which was nice." Similarly, another

study participant said one of the conferences she goes to is "known in my field for being good for students because they give a lot of priority for students to present instead of professors and lecturers and researchers, which is good that [it] gives us visibility."

Recognition was also facilitated by other academics approaching participants after their presentation. This sometimes resulted in internships or post-doctoral positions. As one participant noted, sometimes new study ideas or new applications for theories surfaced at conferences, bringing feelings of being recognized by more senior academics.

Competence

The science identity dimension of competence relates to participants' self-perceptions of their own knowledge and understanding in their field or a perceived lack therein. One participant noted "It's hard to trust in your own confidence, in your own abilities, even in the validity of your research, when you are speaking with people who are really familiar with the system." Another participant commented on the egos that can flare up in conference settings, making participants question their competence:

> The question-and-answer section … would be scary depending on who was in the crowd. [You'd ask yourself], do they know your supervisor, do they know the work, are they doing similar work or competing for work and are they genuinely asking interested questions or are they trying to trip you up?

Imposter syndrome presented a further barrier to feeling competent. As one participant said, "These people know what they're talking about and I might look silly if I make a mistake." Another noted, "I could do all the preparation in the world to do the actual presentation, and then this was the time that they were going to figure me out." In addition, participants reported not finding their "voice" at academic conferences. As one participant shared, "I had questions, but I thought, 'No, I'm just not going to ask … those questions.'… I did hold back a little.'' Another echoed this sentiment, saying:

> There's no way that as a student I felt like I could approach anyone who I had identified as being cool to talk to because they had so many other people talking to them … I felt like they wouldn't want to talk with me. I was just gonna annoy them after a long flight … or I didn't have anything useful to talk with them about.

It was challenging to build a feeling of competence at a conference when the role models were mostly older, white men. One participant noted, "It's a bit

daunting. I think I have the idea to ask myself, 'Am I ever going to be at the same level … or should I just be there in my corner and just learn from it?'"

Several interviewees commented that they had to convince the audience of their findings' validity and felt their status as a woman exacerbated the need to do so, such as the participant who said, "I have to defend [my findings] more than a male scientist." Another corroborated this, noting, "I think they tended to expect the woman to back down faster than men … if the person asking the questions had an opposing viewpoint." Another reported, "The male PhD students I spoke with didn't have any of the qualms that I did. They felt very much like they belonged there."

In contrast, confidence was enabled through positive opportunities for discussion, opportunities to build self-confidence, and feeling supported by supervisors, other students, and conference audiences. As one participant reported, "I was expecting push back… but most people were just really fascinated with the findings and found it really relevant. It actually sparked a really great discussion." This sort of experience built the participant's sense of competence, especially when she went into it "quite apprehensive" about how her findings would be received. The role of support from peers in building confidence was noted by several participants. As one shared:

> Something that I found really [important is] having team members at conferences and not doing it alone. I'm not sure if it's a woman-specific or younger woman-specific thing, but it's just been really nice to have some back up there and particularly having younger female members of my research team, … having a supportive friend who can either make an introduction or can feel nervous with you when you approach a senior academic or even just be a friendly face in the room. Just having that support, I find it valuable.

Having other women to bond with and challenge gender norms with helped our participants build the science identity dimension of competence in a supportive, collegial manner. Self-confidence can also be "faked," according to some participants, if they have not yet developed the feeling of competence. As one participant shared:

> When I've had feedback on my peer-reviewed papers, I tried to put on a different persona, I pretended that I am a supervisor rather than a PhD student. I tried to imagine what she would say, because she has that seniority, because she has that experience. I try and shut out the PhD student and put that in the corner for a little while. Pretend that I have that experience and that I do know

> what I'm talking about. Because I probably do, but I just feel like I don't.

Faking confidence kept our participants from feeling demoralized by early experiences that would otherwise lead them to question their competence. Science identity does not follow a linear path of gaining confidence with each experience; putting yourself in others' shoes – who are more experienced but still receive harsh feedback – can make rejections less wounding personally.

Ideas to increase gender equity in STEM academic conference spaces

It was clear in our interviews that combatting inequities at STEM academic conferences requires systemic changes, rather than expecting women to adapt to a man's world. As one participant put it, "I think it would be really nice to make sure that conferences are more welcoming to females, but I think that requires a large culture shift more so than it does women learning to adapt…. It would be nice to just have less of the blatant sexism." Similar sentiment was noted by another participant, who said:

> If there's any resource developed to help female students, it needs to be in conjunction with changing the … way conferences are conducted, otherwise it just becomes a deficit thing where female students just need to be more confident or just need to not worry about this or need to be more assertive. There's some room for that, because of the way that we've culturally been shaped, but at the same time, I think that by itself is insufficient. You need to … [have] a policy that a few keynote speakers have to be female and some action from the other side.... It's not one thing, it's just lots of things that add up…. Often, it's not extra training that's needed for female students, it's that plus dismantling the structures … that make it difficult in the first place.

Another suggestion was that conference organizers could create intentional avenues for mentoring rather than expecting doctoral students to have the confidence to engage with senior academics during informal networking events. As one participant reported:

> The best [conference] that I went to was in New Zealand … where they matched students with a keynote-level speakers and did a workshop with them. You could actually have one-on-one time with them. I found having some kind of structure in place to be way more helpful than expecting these things to happen organically.

Echoing this sentiment, another participant recollected, "the best things I got out of a conference was when it was a structured time where you could speak with people who are already established in the field and talk with them about your career in a 'speed dating' situation or workshop."

A final suggestion from our participants was that conferences should offer childcare services so that doctoral students who are parents do not have to choose between attending conferences and parenting.

> It's definitely not something that's … widely spoken about or even broadly mentioned in any registration or anything like that. It would be nice to be able to say, 'Look! there is this option and it's advertised.' It [shouldn't be up to us] to go digging around for. I have … three friends [who] have given birth in the past year. They're probably looking at not going to conferences for quite a while.

While childcare services would benefit male students with children as well as women, participants noted the gender imbalance of women more often needing to leave a conference earlier to care for children or skipping networking events to have video calls with their children back home. If conferences provided childcare services, parents would not have to make the choice between family responsibilities and conference attendance.

Discussion and Implications

Our findings illustrate a continued need to combat gender inequities in STEM fields and reimagine conferences to be more inclusive of women doctoral students. In New Zealand, there's a saying among school teachers that "what is good for everyone is not always good for Māori, but what is good for Māori is good for everyone," meaning that all students benefit from culturally responsive pedagogy and inclusive instructional practices. Similarly, our participants made the case that what's good for women in STEM is good for everyone. Academic conferences, as a pathway into careers and a building block of science identity development, should be inclusive, welcoming spaces in which everyone feels enriched, respected, and valued. However, what we heard from our participants reinforces the decades of research that has shown bias on all levels, from conference planning – both the formal aspects of who the keynote speakers will be and the informal aspects of providing safe transportation to evening networking events – down to ensuring that actions that show overt bias are not tolerated by individuals at the conference.

The types of biased conference experiences relayed by our participants are neither new nor likely to disappear without a concerted effort to dismantle inequitable structures and change biased beliefs. Our participants stressed that the responsibility for these changes lies squarely with those in power, rather than

expecting women to "try harder" to fit in. Individual women may be able to break through barriers, but as our participants noted, this is often at the cost of sacrificing their own identities. Figuring out how to dress to be seen as a "scientist" (i.e., whether to don high heels) should not be part of the academic journey for women pursuing a PhD (in STEM or any field). Science identity should be developed through activities (like academic conferences) that strengthen self-efficacy around a woman's performance, recognition, and competence, not hinge on "playing the part."

Several implications emerge from this study, for conference organizers and institutions of higher education, to promote gender equity. Conference organizers can be intentional about providing opportunities for conference participants to engage in formal networking opportunities. They can offer group transportation to evening events to make women participants feel safer, and can offer childcare on site to facilitate attendance by women with children, a need noted in the prior research (Case & Richley, 2014; Cidlinska, 2018; De Welde & Laursen, 2011). Higher education institutions (HEI) can offer doctoral students informal opportunities to present their work, thus increasing their comfort at conferences to show their *competence,* engage in *performance*, and receive *recognition*. HEI can also offer women more funding for research assistant positions, in line with Ampaw and Jager's (2011) finding these RA positions are generally given to men doctoral candidates. HEI's can also offer women doctoral students conference funding, to combat the finding that financial constraints hinder women from attending conferences (Mwenda, 2010).

Conclusions

Studies like this, while not generalizable to the broader population, shine a light on persistent barriers to the equal participation of women in STEM fields. The semi-structured interview approach allows for rich, qualitative insights, and we acknowledge that the reliance on self-reported data introduces potential response bias (Last, 2000) as we asked participants to recall past experiences from their doctoral journeys. Additional research is needed to bring these barriers to the policy agenda at universities, conference organizers, and within state and national governments. Mixed methods studies that combine qualitative interviews with quantitative measures such as surveys would help validate and enhance generalizability of the findings. Longitudinal qualitative studies that compare and contrast women's experiences in different universities across a range of international contexts and STEM subfields would also enrich the findings. In addition, studies of the compounding bias experienced by non-white women, women's whose primary language differs from that of the conference, cultural and socioeconomic factors which might intersect with gender to influence conference experiences, and the specific intersectionality of bias for doctoral students who identify as non-binary, would all make valuable

contributions to the goal of cultivating equitable education systems, workplaces, and societies.

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