CHAPTER SEVEN

Who's the Expert?

Gendered Conceptions and Expressions of Expertise by Chemists-in-Training

Laura Hirshfield

Women face numerous challenges in academic science. While there have been measurable improvements, women still fall short in several key areas of scientific career success compared to men. Their salaries are lower (Toutkoushian and Conley 2005); they are promoted at a slower pace (Valian 1998); and they drop out of science, technology, engineering, and math (STEM) majors, graduate programs, and careers at higher rates (Xie and Shauman 2003). Discussions of women's difficulties along the STEM pipeline often focus on the points at which they "leak out." Rather than focus on "leakage," this study explores the challenges that women scientists who persist experience. Specifically, I investigate the professionalization of academics during graduate school and in postdoctoral fellowships, to examine how gender impacts conceptions and expressions of expertise.

Women graduate students and faculty members in traditionally male disciplines (including most STEM fields) are at a greater risk of experiencing gender discrimination and harassment (Ecklund, Lincoln, and Tansey 2012); are burdened with extra formal and informal service responsibilities (such as sitting on diversity committees or mentoring women students, sometimes called "identity taxation") (Hirshfield and Joseph 2012); and receive less mentoring than their men colleagues (Johnsrud 2002; Moss-Racusin, Dovidio, Brescoll, Graham, and Handelsman 2012). Gendered stereotypes also lead to lower expectations of women's ability and harsher evaluation of women's research accomplishments, particularly in the sciences, where knowledge production is paramount (Steinpreis, Anders, and Ritzke 1999; Wenneras and Wold 1997). However, since expertise and knowledge are differently valued and expressed depending on particular social and gendered contexts, it is important to examine more fully how expertise and status are linked, as well as how these links might impact women's success in academia and science (Evans 2008; Keller 1985; Harding 1991).

In this chapter, I explore expectations about and expressions of expertise in men and women chemists-in-training to investigate an important avenue through which women scientists may face barriers to success. I focus in particular on how expertise is established, portrayed, and interpreted in daily interactions, and whether gender plays a role in these processes. Given the importance of knowledge and expertise within the field of science, divergent methods of expressing and demonstrating knowledge may diminish women scientists' ability to compete with their men peers. I argue that men chemists are more likely to be seen as experts, both by other men and by their women peers, because they are more likely to be viewed as highly knowledgeable, more likely to gain specialized knowledge, and more likely to volunteer their knowledge or to accept others' definitions of their expertise in group settings. Some women are also more likely to be seen as experts regarding knowledge that is related to successfully navigating the academic program, the research group, or the laboratory itself, rather than science more broadly.

Science, Expertise, and Gender

Academic disciplines train students to specialize not only in their relevant knowledge bases, but also in the different norms, work patterns, and interpersonal interactions that take place within these disciplines (Anderson, Louis, and Earle 1994; Becher 1987; Evans 2008). Further, graduate school socializes students to become members of the graduate student community, of the academic community as a whole, and of their discipline or field (Austin and McDaniels 2006). Although graduate school is intended to prepare students for the academic job market and for life as a faculty member, most graduate students find their preparation to be lacking.

Expertise

Within groups, knowledge and expertise are often linked with status. Indeed, a professional's power and authority are rooted in both her specialized knowledge and her control over interpersonal situations (Larson 1979). Thus, interactions with other group members and members' judgments of an individual's knowledge and expertise can become key factors in determining who will have status and power within a group. However, experts do not always need a record of excellent performance to convince others of their abilities or knowledge, but can use impression management to project self-confidence to imply to others that they are highly skilled (Goffman 1959; Shanteau 1988). There are several key ways that individuals' expertise are judged: 1) credentials, which might include certification, course-work, or graduate degrees; 2) an individual's track record, or demonstrations of previous success in a given field; or 3) long-term participation or experience in the field (Collins and Evans 2007).

Expertise is also directly linked with knowledge, of which there are several relevant forms. Explicit knowledge is easily classified, recorded, and communicated through formal (often written) language (Polanyi 1966; Nonaka, Toyama, and Nagata 2000). Tacit knowledge, on the other hand, involves unspoken rules that are not easily transmitted, tend to be abstract and obscure, and can be communicated much more easily through active interaction with others (Collins 1974). An important example of tacit knowledge, in the context of this analysis, is knowledge about how to use scientific equipment. Finally, another key type of knowledge in the natural sciences is local knowledge, or information that is specific to the limited context within which individuals work (Knorr-Cetina 1981; Cambrosio and Keating 1988). For scientists, this is the laboratory or university. This kind of knowledge might include information about where to find certain kinds of glassware, how a particular piece of troublesome machinery works, or how best to approach specific peers and advisors for help.

Gender & Expertise

Unsurprisingly, gender is related to men and women's access to knowledge and ability to be perceived as experts. Gendered expectations about what kinds of educational, career, and behavioral choices are appropriate influence how men and women are understood and evaluated by their students, peers, and superiors (Valian 1998). In the natural sciences, long-held cultural associations between masculinity, male bodies, rationality, and science, grant men access to expert status much more quickly and easily than their women peers (Keller 1985). When assumptions of men's "natural" superior technological skill are questioned, the social construction of these assumptions becomes more obvious (Abiss 2007). On the other hand, gendered patterns of interaction affect how men and women communicate their expertise to others (Crosby & Nyquist 1977; Hirshfield Forthcoming). Indeed, there is good evidence that women are more likely to use speech patterns that moderate the strength of their statements or make their comments sound tentative. These behaviors include hedging (such as beginning a comment with "I'm not sure, but") or disclaiming their expertise entirely (Leaper and Robnett 2011).

While previous research has explored definitions of expertise and gendered experiences in sciences, few studies have brought these areas of research together. Thus, in this chapter I ask: "How do men and women in chemistry training programs (i.e., graduate students and postdoctoral fellows) conceptualize and express their expertise and knowledge? How do principal investigators and fellow graduate students and postdocs identify experts? And, in what ways are these conceptualizations, expressions, and identifications different for men and women chemists-in-training?" Given previous research demonstrating that women feel that they are less likely to be seen as experts and that they receive less respect from faculty than their men peers (Fox 2001; Johnsrud 1995), qualitative research exploring knowledge and expertise in these settings is important for understanding these processes more completely. Further, insight into the development of gender differences in expressions of expertise has significant implications for women's success in academic science.

Method

This study draws on data collected during nine months of ethnographic observation in the research laboratories of five groups in the chemistry department of a large research university, from 2009 to 2010, as well as 40 in-depth semi-structured interviews, and select content analysis of lab manuals and websites.[1] I concentrated my analysis on chemistry because, at the time of my study, the majority of practitioners in industry, academia, and doctoral programs were men (Hill, Corbett, and St. Rose 2010). On the other hand, women were making significant headway in the field. Specifically, 33.1% of the workforce and 34.3% of graduate students were women at the time of this study, and these proportions have been increasing steadily.

The proportion of women faculty in chemistry at this university was fairly low (approximately 25%), but within the past eight years, the proportion of women has doubled. Women graduate students represented nearly half of the total graduate student population (49.2%), which was above the national average. By contrast, the department was not very racially diverse: roughly

84% of graduate students were White, 5% were Asian, 4% were Latino/Hispanic, 4% were Black or African-American, 1% were American Indian/Native American, and 1% were unknown/unreported (NSF 2009). In choosing groups to observe, I identified those that had more than six students, as well as a principal investigator (PI) who was early in their career. Of the thirteen professors I contacted, five agreed to be involved in my study.[2] Of these groups, two were led by men (Professors Mitchell and Moore) and three by women (Professors West, Williams, and Worth).[3] The smallest group I observed had nine members in it (not including the PI), and the largest had twenty-one.

Ethnographic Observation

The first phase of my data collection involved ethnographic observations that occurred over the course of nine months, comprising over 120 hours. Using an inductive approach, I noted interactions between the group members, how speakers and group members presented themselves in meetings and in the lab, and variations in teaching or mentoring modeled in each group. In total, I observed 56 graduate students and nine postdocs, as well as their five principal investigators. The groups I observed varied in their percentage of women members (23% - 60%), in terms of race and ethnicity, and in proportion of various scientists-in-training (undergraduate, graduate, and postdoc).

Interviews

I was able to interview over half of the population I observed: in total, 40 semi-structured interviews of graduate students and postdocs, 19 of whom were men and 21 were women. My primary focus was on graduate student training and experiences, so the majority (n = 37) of my interviews were with graduate (PhD) students, though I interviewed three postdocs about their experiences as well. While race and other social factors such as age, class, and sexual identity likely also impact the negotiation of knowledge and expertise, I was unable to limit the possible pool of respondents based on these factors due to issues of access. I recorded relevant demographic information using a short demographic survey and these factors were considered during analysis. Ten of my interviewees were international students, which is comparable to representation of international students in the chemistry department; whereas all but one of the domestic students I interviewed were white.

Interviews lasted roughly one to 1.5 hours, most were conducted in private office spaces. A sampling of topics discussed include: lab dynamics and relationships within their research group; experiences with teaching and authority in the classroom; and their overall images of scientists. The quotes from field notes and interviews I include in the following sections are examples of representative patterns in my data; they have been lightly edited for clarity.

Analysis

My analytic strategy involved open and focused coding (Emerson, Fretz, and Shaw 1995). This analysis focuses mainly on themes that emerged from these data; specifically, the use of authority and expertise in graduate experiences, group norms, and student mentorship. Given my interest in social inequality and identity, I paid particular attention to any patterns that emerged regarding gender, race, or nationality. Lastly, within the themes and trends I explored, I was careful to look for disconfirming evidence and occasions when the patterns I expected did not emerge.

Results

In examining expertise in a scientific lab, I paid particular attention to who graduate students and postdocs turned to for help or advice in solving problems in their work. In the absence of direct ascriptions of expertise, I assumed that those individuals to whom students turned for advice were viewed as experts by those seeking help because individuals are likely to seek advice only from those they deem likely to have sufficient knowledge (Haythornthwaite 2006). Past research demonstrates the importance of clear communication about "who knows what," as well as how individuals' standing as an expert can become crystallized within a group, both of which are addressed in this study (Wegner 1986; Haythornthwaite 2006). Indeed, the graduate students and postdocs I observed described a variety of factors that they used to determine whom they should go to for advice about their chemistry.

The simplest factor chemists-in-training used to determine who they should ask for support was basic proximity: participants often looked to those around them for input. However, although factors such as proximity often influenced who participants *talked to* about their work, ascriptions of expertise were the primary factors through which chemists-in-training determined who to go to for *advice*. Students and postdocs assessed the following: overall skill, talent, or intelligence; specialized knowledge regarding instruments or chemistry subtopics; and expertise about individual research groups, departments, or career-paths (i.e., local knowledge). These assumptions of knowledge and expertise were also greatly affected by gendered patterns of presentation and interaction in group settings.

Overall Skill, Talent, or Intelligence

Unsurprisingly, many of my participants told me that when they needed help they sought out the most senior students or postdocs in their labs. For example, Sarah explained that in terms of science-related questions, "I do think there's definitely a seniority thing there where, Anthony is a senior member. . . . Steven, Chad, I'm forgetting one of them, Kyle, are kinda the senior members right now, and so you tend to gravitate to those people, I think (Williams lab, white woman)." Indeed, there was a clear link in participants' minds between the seniority of graduate students and their overall skill in the lab: the most advanced graduate students in each lab were expected to be the most knowledgeable and to be the "best" chemists in the groups.

Students also articulated that other factors, such as being a "really excellent scientist" shaped their choices for experts and helpers. Kira explained this concept well when discussing Sean's skill and proficiency, describing him as one of the students who others tended to listen to and go to for advice. When I asked her to tell me more about why students went to him for help, Kira said, "He's so good . . . he's phenomenal. I'm just like gosh, how does he know all this stuff? He [asks] such good questions (Kira, Mitchell lab, white woman)." Kira implied in this comment that she was extremely impressed by Sean's knowledge and ability. Andrea's comments about two of the students in her lab were very similar in sentiment:

> There's [one] student who is actually a third- or fourth-year, and I'm a fifth-year. . . . And he's brilliant. He gives me advice all the time . . . [And another student] is very, very knowledgeable. He's also brilliant. It kinda makes me see these people who are just so damn smart, and I'm like man, I feel like I'm a moron, you know. (Andrea, West lab, white woman)

Both Kira and Andrea idolized the intellect of the men, using words such as "brilliant" and "phenomenal," while diminishing their capabilities by extension saying, "gosh, how does he know all this stuff" or "I feel like I'm a moron." Both of these sentiments suggested that they were intimidated by their (men) peers at times, a sentiment that was not echoed by the men in these groups.

Kira's earlier comment that Sean asks "such good questions" also highlighted one of the ways that students and postdocs use group meetings: to elicit information about how "smart they are" or "how good at chemistry they are." Quan explained this phenomenon, judging students or postdocs' intelligence or skill during group meetings more fully:

> We have new postdocs coming in all the time. After a week people start to realize whether or not he's good, what field he's really good at, and also people will look at the old papers he published, the old work he had been working on . . . people will realize whether or not [you're] good or which area you are good at really quick. We have group meetings, so people ask questions, people get feedback, and you can always have a good idea about how good a person [is]. (Quan, Williams lab, Asian man)

Since postdocs enter research groups with higher external credentials than the graduate students in the group, but often have less direct knowledge about the specific instruments or reactions that each group works with on a regular basis, they face a unique set of challenges to their expertise. Thus, group meetings, especially postdocs' first presentation to their new research group, are an important opportunity for them to demonstrate their expertise and for the rest of the members of the group to determine whether they are worthy of being considered experts.

Notably, in the course of my observations in group meetings, in the lab, and in my interviews, I frequently overheard comments or was told directly about approximately eight "stellar" scientists. Of those who were either described to me or who I overheard being called "so good," all were men, with the exception of one third-year woman graduate student in the Williams lab. Indeed, within most of the groups, at least one graduate student was clearly seen as superior to the others by other group members, as well as by his or her PI, and in most cases, that student was a man. In the case of the Williams lab, the woman graduate student shared her role as "superior" or "star" of the lab with at least one other man student.

Specialized Knowledge and Expertise

When graduate students and postdocs required help with their chemistry they generally employed one of several methods. The simplest method for a group member to determine who they should ask for help was to simply ask around the lab to find someone who had previously worked with the particular compounds, reactions, or syntheses for which they needed help.

Usually this occurred in small one-on-one conversations, but sometimes it also involved more public conversations such as the one Joseph described:

> . . . something will come up, and I'll just mention out loud, like Ahmed, Jun, whoever else is around, do you guys know anything about whatever. Somebody'll say 'oh, I know that Maria from the Moore group did that, you should go ask her.' (Joseph, Mitchell lab, white man)

In the process of asking around the lab, students may gather information about who had done a specific reaction, as well as discuss who is particularly adept, expert, or knowledgeable at working with specific compounds, running columns, or using instruments. Importantly, lab members' knowledge about others' expertise and skill is contingent upon students' and postdocs' willingness to advertise or flaunt their knowledge to others, which may be gendered (see Hirshfield forthcoming).

Group meetings are designed to provide students and postdocs an opportunity to practice presenting their research, as well as to receive feedback from their principal investigator and peers. They also provide a chance for group members to learn what their peers are working on. Recalling who gave presentations on related topics in group meetings is another method group members used to determine expertise. As Michelle explained, "Yeah . . . from group meetings we get a good feel of what other people's projects are, so if you can sort of keep track of that in your head . . . you can just get a feeling of who [a topic is] most relevant to (Williams Lab, white woman)." The most common model for research meetings was one in which the members of the group presented their research on a rotating basis.[4] Given the size of the groups (and periodic interspersed practice talks and literature meetings), each student or postdoc usually presented their work at most once a semester. In this model, it was difficult at times for students and postdocs, especially those who were new to the group, to learn what all of the group members were working on. In fact, the only way that people could share their knowledge or establish their expertise was through their questions and comments. Thus, one key way to establish expertise was to ask questions that began, "when I ran a similar reaction using this other method, I found . . . ," this style was more frequently used by male students and postdocs.

Additionally, several of the graduate students in these labs were asked to become experts about specialized topics or, more commonly, machines or instruments needed in the lab. While it was common for both men and women students and postdocs to be assigned roles and responsibilities in the labs, which often included responsibility for machines used in group chemistry, when members of the group or the principal investigator decided that a new machine or instrument should be purchased, men students more often took the lead in becoming knowledgeable about safety and best practices for them. There are two possible reasons that these students were more likely to be men. First, there is evidence that boys are more likely than girls to be exposed to computers and technology during childhood and adolescence (Abbiss 2008). Second, there is a strong cultural association between men and technology (Wacjman 1991; Clegg, Trayhurn, and Johnson 2000). This link is related to stereotypes about gendered differences in technological skill and ability. Accordingly, men graduate students seemed more likely to be aware of new technologies (and to recommend to their PIs that they purchase them). Men were also more likely to be viewed as experts about current instruments in their research groups. When graduate students were asked to learn more about a particular machine, their role as expert in the lab was usually made clear to the entire group during group meetings. In most of these cases, the student taking on the role of expert had expressed a particular interest in a process or instrument, received training on that process or machine (either at the University or at a seminar elsewhere), and returned to the group to answer questions and teach them more about it.

The third way that graduate students and postdocs learned about others' knowledge was that the PI directed them to a group member whose expertise was most related to the topic of concern. This happened most frequently in the Williams lab, especially during group meetings. This also particularly solidified the sense that specific people in the lab were (and should be) considered the experts in specific topics or fields. While Professor Williams sometimes privately told her students to seek help from their peers in her individual meetings with them, she also asked particular students to give their help in group meetings. In the process, she announced their expert status to the entire group. In some cases, she simply advised students who had previously done similar work to help their more junior colleagues so as not to "reinvent the wheel." For example, during one group meeting (Williams Group Meeting 7.31.09), Professor Williams turned to Ethan (the most senior member of the group) to ask him why he thought something was happening in the presenter's results, making it clear that the presenter's work was related to Ethan's, and Professor Williams felt Ethan could provide insight into the strange results. Similarly, in a group meeting several months later, the entire group had a long discussion about how to use a particular method for synthesis that Joanna, the presenter, was struggling with:

> Professor Williams asked Steven how he did something so that he could pass along this information to Joanna. He hadn't done it. She then asked Quan how he did it. He hadn't done it either. Then Steven said that Adriana had

done it and so Professor Williams turned to her and Adriana explained how she did it to Joanna. (Field notes, Williams Group Meeting 10.8.09)

Professor Williams' goal here was to elicit information for Joanna to help her successfully complete a synthesis. Yet, in calling upon particular students, she marked them as people she expected to have had experience with the process they were discussing (though they had not), and also as people whose knowledge and advice was worth listening to. Notably, throughout the conversation, Adriana, who was the only person in the group who actually *did* have experience with the method the group was discussing, did not speak up and describe her experience until she was specifically called upon by Professor Williams.[5]

In other cases, groups of lab members, rather than individuals, were asked to help out presenters when they were struggling or when a question arose during a presentation. In these instances, members were identified as experts in a particular area and were asked to speak up. For example, during one meeting in the Williams Group I noted the following exchange:

> Professor Williams: Do any of the organic folks know?
>
> Adam starts to talk, but Professor Williams interrupts and asks, "Where's Sachi? Didn't you do your seminar on . . .?"
>
> Sachi waffles a bit in her answer.
>
> Adam looks like he wants to talk and Kyle says, "Adam looks like he wants to pop out of his seat." (Williams Group Meeting 9.10.09)

In this case, Professor Williams first identified a group of experts ("the organic folks") who might be able to answer the presenter's question. She then focused her attention on Sachi, who seemed unwilling to speak to the issue. In contrast, Adam, a postdoc who was new to the group, was anxious to share his knowledge; however, given that Professor Williams knew a lot less about his knowledge base, she was much less likely to call upon him for advice in meetings.

Similar to Adriana's reluctance to speak up until called upon, Sachi was uncomfortable acting as the expert regarding a topic that was in her area of expertise. This type of reticence was not uncommon amongst the female members of the group. I noted multiple instances in which women in the group did not speak up about a topic, despite the fact that it was clear (usually through subsequent discussion or sometimes through quiet discussions that I overheard) that they were a qualified expert. Often, the women I observed seemed both less invested in expressing their expertise, as well as less confident in the level of knowledge they needed to have to speak up. In other words, similar to other educational contexts, men seemed much more confident speaking up with incomplete or incorrect answers, while women did not (Lundeberg, Fox, and Puncochar 1994). However, because women often waited to display their expertise until they were called upon, the gender balance of expressions of expertise was greatly affected.

It is clear from these results that one of the key ways that individuals are deemed experts is through interactions with others: people are told that a lab mate is particularly knowledgeable about a specific chemical or reaction; they learn who knows the most about instruments during group presentations and announcements; and, principal investigators are often involved with identifying individuals' expertise during one-on-one exchanges and in larger group meetings. These interactive methods of expertise labeling are gendered in several ways, however. First, given the cultural association between technology and masculinity, it is not surprising that men were more likely than women to become the experts on new technologies within these lab spaces. However, given that knowledge about types of new instruments and machinery generally affords graduate students expertise beyond their principal investigators', the greater likelihood for men to gain these skills is an important gender difference in graduate students' training. Second, men graduate students and postdocs are more likely than their women peers to volunteer their chemistry knowledge in group contexts. More importantly, when others identify them as experts, they are more likely to accept others' definitions of their expertise.

Local Knowledge

When graduate students and postdocs were asked whom they commonly went to for help, many respondents discussed the importance of advice about the way that the lab worked, how to handle the PI, and getting a job in nearby chemical industries, all examples of local knowledge rather than specialized information about how to do chemistry techniques. These questions involve professional advice, support, and a level of mentoring beyond the kind of basic technical assistance that peers more commonly provide for one another. I found that women students were much more likely to be the ones whose expertise in these areas was requested by their peers. For example, Jennifer explained,

> People come to me for advice usually like when they're getting ready to graduate. So like I went through Sun Hee's CV [Curriculum Vita], and I gave her contacts at different companies and like, yeah, and like head hunters that I've

> worked with and said oh, you should contact this person, and this is how you get your stuff out there, and this is what you do if you wanna go into industry. I don't know a whole lot about academia. But I think that's typically my role.
>
> *Why did they think that was your role?*
>
> I think because I've done it. And for the position that I was in, it was pretty successful. And I think I still have a lot of contacts in that specific area. (Jennifer, West lab, white woman)

Jennifer had professional experience prior to her time in graduate school, but so had her colleague, Todd. While they were both often asked to comment about their time in industry during group meetings, in contrast to Jennifer, Todd was not approached for this type of help outside of group settings.

Women were also more likely to be asked to give advice about lab dynamics and interactions across multiple settings within the groups. These women students and postdocs were expected to give career and school advice, support others with their work, and provide insight into group dynamics. Lindsay explained that when she needed help with her science, she tended to go to one of the more advanced men in the group, Ahmed, but when she wanted to better understand group conversations, interactions, and jokes, she spoke with Carrie, a woman who sat near her. She described this dynamic:

> So I guess it's different aspects with different people. So in terms of like general where stuff is, explaining to me lab dynamics and conflicts, and more social things, the girl that sits next to me, her name is Carrie, she's been really great. . . .
>
> *What kinds of stuff did you need insight about that Carrie . . . ?*
>
> Oh, just like, 'is that a joke?' [laughs]
>
> *So people would be teasing each other or something, and you'd say, 'what's going on?'*
>
> Yeah. They're very, they had this thing, like especially Kira and Sean, where they'd try to say things as deadpan as possible. I'm not so good at . . . I'm like 'are they kidding or not?' [laughs] (Lindsay, postdoc, Mitchell lab, white woman)

As a new member of the Mitchell group, Lindsay explained that it was difficult at times to adapt to the way that things worked differently than they had in her previous research group. She found that Carrie's help in interpreting the nuances of her colleagues' interactions helped her to feel more comfortable and less out of place overall. It was clear in our conversation that she valued this support nearly as much, if not more, than she did the scholarly help she received from the advanced men students in the group.

Several of the women students described relationships with other women that sounded as if they helped give each other guidance on how to successfully navigate the academic program as well. This mentorship between students occurred at times in mixed-gendered settings, but seemed to be most common, and most thorough, with woman-woman pairs. For example, when I asked who tended to come to her to ask questions, Zhi told me that a second year grad student who worked with her when she did her rotation goes to her "when she has questions, because she's doing all the things that I have done before, like candidacy, making posters for the conferences, and how to label things" (West lab, Asian woman). In this case, the supervisory role of mentor to a rotation student extended beyond simply teaching the younger student basic information about chemistry techniques, such as using instruments, to academic guidance. A similar form of mentorship was obvious in the Moore lab. When I asked Erica who she went to for help, she replied,

> Monica. I ask Monica for a lotta help and guidance. Yeah, 'cause she's the only that has done it in our lab and the only one I can honestly look up to. I mean I can't look up to the guys in my other lab. [laughs] But like going through [the qualifying exam], Monica was willing to proofread my work and gave me suggestions. . . . [And] it was dead on. It was crazy. And so I'm kinda scared going through the thesis process next year 'cause she'll be gone. (Erica, Moore lab, white woman)

Erica's worry about who she will go to for help in the future was especially interesting given her experience as a support system for several men students in her other lab (she was a joint student and thus a member of two labs). Interestingly, while Erica did provide this support for the men in one lab, she chose to turn to a woman member in her other research group for the support and mentorship she needed. When that student graduated, she found herself with no one to help her out. Within these labs, it was clear that women were more likely than men to be approached by others for help dealing with issues pertaining to local knowledge, the information that applies specifically to interactions within their group, progression through their specific chemistry program, or information about functioning within their own specific laboratory context. While this type of expertise is immensely important to both graduate students and postdocs while they are in their particular training contexts, it will also be less valued in their future careers than the expertise associated with explicit and tacit knowledge that men students and postdocs were much more likely to both express and be associated with.

Conclusion

Chemists-in-training use several different factors to identify sources of peer support and expertise to guide them during their time in graduate school, including interactions with other group members and with their principal investigators. Unfortunately, women graduate students are far less likely to be viewed as, or to view themselves as, experts within these research groups. While men and women seem equally likely to turn to the peers that are near them for help, several explained that they sought out people with whom they had a closer bond because they felt more comfortable showing their lack of knowledge to them. There is also evidence from several studies that women may be more likely to use the latter strategy because they fear reinforcing negative stereotypes about women in science (Major and O'Brien 2005; Hirshfield 2010). Unsurprisingly, men and women often approach the most senior students in the lab for advice, because there is a strong belief among the members of these groups in the correlation between time in the program and skill and/or overall expertise. However, there are also several students in these groups who are known to be especially strong students. All but one of these students were men. Additionally, several women students expressed feelings of intimidation when comparing themselves with these "star" students. This is of particular note given academia's high stakes system in which only the most successful secure faculty positions.

Men and women students' expressions of expertise also diverge in several ways. First, perhaps because of cultural associations between men and technology, men were more likely to become clear, obvious experts of new instruments in the group, and in the process, gain an expertise beyond that of even the principal investigator. Next, when PIs identify specific members within the group as experts, men tend to be more willing to speak up and embrace their knowledge and expertise. This is not surprising given previous studies that reported women feel less comfortable than men speaking up in group meetings in general (Fox 2001). However, as a consequence, women are not seen by others, including their principal investigators, as competent and confident. Finally, women are more likely to be expected to act as the experts in a variety of forms of local knowledge, including advising about lab interactions, proofreading work, and help with graduate school requirements.

These findings show that, in day-to-day interactions, men are more likely to be seen as experts in chemistry, both by their men and women peers. When they are asked to be experts by their peers and by their principal investigator, they are able to practice one of the most important skills of faculty members in their discipline: thinking through a question in their field, applying it to the topic at hand, and answering it with confidence. Women, on the other hand, are less frequently seen as experts by themselves or others. Consequently, they benefit from far less training and practice in the actual work of being a professor of chemistry. Additionally, because women are more likely to be seen as experts in local knowledge, they are also expected to shoulder more of the burden of this type of work within their research group. Just as this type of mentorship is not recognized or rewarded among faculty members (Joseph and Hirshfield 2011; Porter 2007; Olsen, Maple, and Stage 1995), it is also not rewarded among graduate students. Thus, women graduate students are more likely to use their time being asked to help their peers in ways that do not benefit their careers, while their men peers are being asked to help in ways that do.

The local versus tacit or explicit knowledge distinction that I describe is similar to the tension for university scientists between local and cosmopolitan orientations described by Hackett (1991). Specifically, Hackett explains that university scientists face seven "value tensions," one of which involves allegiance within the local sphere to their students, departmental colleagues, and to their universities, while at the same time experiencing more cosmopolitan commitments to disciplinary or other scientific collaborators (*ibid*). Hackett argues that financial ties are some of the most important contributions to the local orientation for some scientists, particularly marginal ones, whose position within the university may be less secure; as a result, marginal scientists may be forced to remain loyal to their local institution, rather than create more prestigious cosmopolitan relationships with collaborators in the broader scientific community. Likewise, my results suggest that scientists-in-training face a similar tension between local and "cosmopolitan" (explicit and tacit scientific) knowledge. If women's training is mainly focused on the former, they may miss out on the benefits of a more cosmopolitan orientation.

An additional consequence of my findings involves the relationship between graduate students, postdocs, and their PIs. As faculty advisors, PIs are given the task of offering mentorship, guidance, and references to their students and postdocs as they complete their doctoral programs or fellowships. The differences I have described in the way that men and women act and thus, are likely to be perceived, is likely to greatly impact the types of jobs that faculty believe are appropriate. Academic science depends greatly on the knowledge and expertise of its faculty. Therefore, if women do not gain the same amount of practice and training in engaging with and expressing their scientific expertise as their men peers, they may be at a disadvantage in their later careers. Further, time pressures associated with the expectations of being experts in local knowledge may be detrimental to their success. These elements have likely affected women's advancement in science and are a key feature of gender inequality in the STEM pipeline that calls for further study.

Notes

1. Please see Hirshfield (2011) for a more detailed description of my methods.
2. The professors' ranks ranged from assistant to full professor; however none of the professors had been at the university for more than 10 years. Because of my interests in group dynamics, this was an attempt to disentangle some of the effects of advisor prestige, money, and stability that I felt were likely to arise by comparing across well-established and very new research groups.
3. For the sake of ease, I have used pseudonyms that begin with the letter "M" to denote the professors who are men, and pseudonyms beginning with a "W" to denote professors who are women.
4. Other models include additional group meetings such as "literature meetings," which involve gatherings to discuss recent literature related to research explored by the group, practice talks given by group members preparing for qualifying exams or candidacy presentations, or "sub-group meetings" which are meetings that involve part or all of the group during which students discuss recent reactions, progress, and future research plans.
5. Please see Hirshfield (Forthcoming) for a longer discussion of gendered interaction norms within this setting and their consequences.