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Gender-Related Values, Perceptions of Discrimination, and Mentoring in STEM Graduate Training

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ABSTRACT

Although girls and boys appear equally interested in most STEM fields during childhood and adolescence, men pursue academic research careers in most of these same fields at higher rates than women. We tested several prominent hypotheses concerning the causes of this differentiation. Specifically, 136 (59 women) doctoral students in the United States completed measures of their occupational values, views of the degree to which STEM careers afford their values, perceptions of gender discrimination in their department, mentor support, and satisfaction with their graduate training. Results indicated gender differences in students' occupational values, ratings of career value affordances, and perceptions of gender discrimination. The perception that a STEM research career affords one's values was predictive of women's (but not men's) satisfaction with their graduate training.

KEYWORDS

gender differences; gender discrimination; STEM; occupational values



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INTRODUCTION

Despite decades of effort aimed at increasing women's representation in science, technology, engineering, and math (STEM) fields in the United States, women remain stubbornly under-represented at the highest levels of many STEM disciplines. For example, women received 37.7%, 20.3%, and 21.3% of PhD.s awarded by U.S. colleges and universities in 2009 within chemistry, physics, and engineering, respectively (Snyder, Dillow, & Hoffman, 2009). Furthermore, among individuals who earn PhD.s in STEM fields in the U.S., disproportionate numbers of women fail to turn up among the ranks of assistant professors, and among those women who pursue academic jobs at U.S. colleges and universities, a disproportionate number fail to obtain tenure (Goulden, Frasch, & Mason, 2009; Shalala et al., 2007). Explanations for the gender disparity in STEM fields have been hotly debated for decades.

In this paper, we tested the roles of three frequently invoked explanations for women's underrepresentation among STEM research academics: (a) occupational values, (b) perceptions of gender discrimination, and (c) mentoring. Specifically, we explored whether doctoral students in chemistry and biochemistry at a major U. S. research university (i.e., a large public institution whose primary mission is to generate research and train graduate students) show sex differences within these three domains and then tested the utility of these variables for predicting female and male students' satisfaction with their graduate training. We selected doctoral students at a major research university for participation because such students are highly talented within and committed to STEM pursuits. Furthermore, research suggests that graduate training is a critical period in the shaping of STEM careers (Alper & Gibbons, 1993; Ceci, Williams, & Barnett, 2009; Goulden et al., 2009; Herzig, 2004), albeit there have been relatively few quantitative studies of gender differences in the experiences of doctoral students in STEM fields.

Women and STEM Training

STEM fields are characterized by a "leaky pipeline" ; women's underrepresentation becomes larger at higher levels of education (Alper & Gibbons, 1993; Ceci, et al., 2009). Gender differences in chemistry are illustrative of this effect. In the U.S., for example, more girls than boys complete chemistry classes in high school (National Science Board, 2008), and women and men complete undergraduate majors in chemistry at nearly equivalent rates (Snyder et al., 2009). However, men are more likely to complete PhD.s and to hold faculty positions in departments of chemistry than women (Raber, 2010; Snyder et al., 2009). It appears, therefore, that gender-differentiated experiences in graduate training may contribute to women's failure to pursue STEM careers within academia (Ceci et al., 2009; Cuny & Aspray, 2001; Eccles, 2007). Thus, satisfaction with graduate training may be especially important for predicting successful completion of doctoral work and entry into academic research careers.

Occupational Values and Career Value Affordances

One hypothesized explanation for women's underrepresentation within STEM fields concerns gender differences in individuals' personal values, or beliefs about what is important and desirable in life (Ceci et al., 2009; Diekman, Brown, Johnston, & Clark, 2010; Frome, Alfeld, Eccles, & Barber, 2006). Former Harvard President Larry Summers' 2005 remarks about the underrepresentation of women in academia illustrate this view. At the 2005 National Board of Economic Research Conference, Summers remarked that his "best guess" about the factors that lead to women's underrepresentation at the highest levels of STEM fields is, "the general clash between people's legitimate family desires and employers' current desire for high power and high intensity" (January 14, 2005). That is, Summers suggested that women's personal values led them to invest more time and energy into their families than their scientific pursuits, whereas the reverse was true among men. The notion that the values that a career affords, or provides naturally through work, affect occupational goals has received theoretical and empirical support within the research literature as well.

In her classic model of achievement motivation, Eccles et al., (1983) proposed that males and females endorse differing work-related values, and that these differences, in turn, lead to gender differentiated academic behaviors (e.g., course taking) and career goals (Eccles et al., 1983; Eccles, 1994; Meece, Wigfield, & Eccles, 1990; Watt & Eccles, 2008; Wigfield & Eccles, 2000). Work-related values are multi-faceted; such values include beliefs about qualities of jobs that are important, desirable, and beneficial (see Shechter, Durik, Miyamoto, & Harackiewicz, 2011). In the present study, we examined the personal values individuals hope to fulfill via the world of work. In their social structural theory of gender differences, Eagly and Wood (1999) argued that women and men come to hold differing personal values as a result of their roles within society: women come to prioritize communal and interpersonal values as a result of the societal constraints associated with their gender (e.g., caretaking), whereas men come to prioritize status and power as a result of a differing set of constraints (e.g., providing resources). Consistent with Eagly and Wood's theory, recent psychological research indicates gender differences in such values: women, more than men, value altruism and the flexibility to spend time with family, whereas men, more than women, value power and money (Diekman, et al., 2010; Evans & Diekman, 2009; Weisgram, Bigler, & Liben, 2010).

Extant data concerning the gender differentiation of occupational values are, however, derived from samples of high school and undergraduate students (Diekman, et al., 2010; Weisgram et al., 2010). Little is known about the values of women with strong STEM interest and talent. Do such women show gender atypical career values? Or do they – like their non-STEM interested female peers – also hold traditionally feminine values? Previous research has shown that, even when men and women share the same social role (e.g., hold the same occupation), socially-defined gender roles continue to have an impact, albeit a diminished one, on values and behaviors (Eagly & Johnson, 1990; Gutek & Morasch, 1983; Moscovitz, Suh, & Desaulniers, 1994; Ridgeway, 1997). Thus, we hypothesized that female STEM doctoral students would endorse different values than their male peers, with men

endorsing money and power more strongly than women, and women endorsing altruism and family flexibility more strongly than men (*Hypotheses #1A-D*, respectively; see Table 1 for overview of hypotheses).

In addition to predicting interest in STEM versus non-STEM fields, it seems possible that individuals' occupational values effectively predict career plans *within* STEM fields. After obtaining a graduate degree in a STEM field, students have several career options, including employment within industry, teaching-focused academic institutions, and research-focused academic institutions. Goulden et al. (2009) found that both female and male graduate students rated academic research careers as the least family-friendly of a range of jobs that included careers within teaching-oriented institutions and industry. Furthermore, a report by the National Research Council (2009) found that women were less likely than men to seek jobs at research-oriented, Ph.D.-granting academic institutions. Thus, we predicted that men would view research careers as affording their values to a greater degree than would women (*Hypothesis #2A*). Importantly, teaching intensive positions—even within institutions of higher education—are female-dominated and strongly associated with helping others (Fox & Stephan, 2001). Thus, we expected women would view teaching careers as affording their values to a greater degree than would men (*Hypothesis #2B*). Because industry jobs vary enormously in their settings, duties, and conditions (National Research Council, 2009), we did not expect to find gender differences in the expectation that careers in industry would afford individuals' occupational values.

Gender Discrimination

A second commonly invoked explanation for women's underrepresentation in STEM concerns experiences with discrimination (Ceci et al., 2009). Theoretical and empirical work indicates that perceiving one's ingroup to be stigmatized and treated unfairly within a domain is associated with dissociation from that domain (Steele, 1997; Swim, Cohen, & Hyers, 1998). Importantly, gender stereotypes of STEM ability favor men over women, and consistent with this fact, women are more likely than men to perceive themselves (and other women) as the targets of gender discrimination (Branscombe, 1998; Swim, Hyers, Cohen, & Ferguson, 2001). Women are especially likely to expect (Cohen & Swim, 1995; Steele, James, & Barnett, 2002; Hall & Sandler, 1982) and experience (Grauerholz, 1996; Settles, Cortina, Buchanan, & Miner, 2013) discrimination when they are underrepresented in traditionally masculine fields. Thus, consistent with prior work (Schmitt et al., 2002), we hypothesized that female students would perceive their own gender group (i.e., women) to be the target of gender discrimination more often than would their male peers (*Hypothesis #3A*).

We also examined doctoral students' perceptions of discrimination against men within their department. The topic is understudied, but it seems possible that male graduate students perceive themselves (rather than women) as the targets of gender bias, perhaps as a result of U.S. academic institutions' affirmative action-like measures aimed at supporting female students (e.g., special outreach and mentoring programs; Beaton & Tougas, 2001). Indeed, claims of reverse gender discrimination among men are common in the U.S. (Coston & Kimmel, 2013;

Pincus, 2003). Thus, we expected male students would perceive their own gender group (i.e., men) to be the target of gender discrimination in their department more often than would their female peers (*Hypothesis #3B*).

Mentor Support

A third common explanation for women's underrepresentation at higher levels of STEM fields concerns mentoring. The tutelage provided by an experienced faculty member is one of the most critical of the factors that contributes to success during graduate training, as well as to later success in an academic career (Blackburn, Chapman, & Cameron, 1981; Girves & Wemmerus, 1988; Herzig, 2004; Lechuga, 2011; Long & McGinnis, 1985; Tenenbaum, Crosby, & Gliner, 2001). Tinto's (1993) model of doctoral student persistence posited that faculty mentors act as role models and sources of socialization, and that this socialization is crucial to persistence in the discipline. Effective mentoring practices include showing support and appreciation for individuals' talents and contributions, and a sensitivity to individuals' unique strengths and weaknesses (Lechuga, 2011; McGhee, Satcher, & Livingston, 1995; Wilde & Schau, 1991).

Men constitute the majority of faculty members within STEM departments at research institutions, including the institution from which our sample was drawn (Fox & Stephan, 2001; Raber, 2010). A vast literature within social psychology indicates that individuals show favoritism toward ingroup members, including same-gender individuals (see Hewstone, Rubin, & Willis, 2002). Thus, it seems possible that male students perceive themselves to be more strongly supported by their mentors than female students (*Hypothesis #4*). This hypothesis assumes, however, random assignment of students to the male and female faculty mentors within a department. We tested this assumption and, because it did not hold, we also tested the hypothesis that individuals with same-gender mentors perceive greater mentor support than students with other-gender mentors (*Hypothesis #5*).

Relations Among Major Variables

Most work examining the roles of occupational values, discrimination, and mentoring in shaping academic and vocational goals and trajectories has examined these factors in isolation, and thus almost nothing is known about the possible relations among them. We tested several hypotheses about the relations among these major variables. We first tested hypotheses concerning individuals' specific occupational values and their perception of the degree to which STEM careers in research and teaching afford their values. We expected individuals—both men and women—who value money and power to view teaching careers as failing to afford these values, in part because teaching is a relatively low status and low paying profession (*Hypotheses #6A and B*). Valuing family flexibility is also likely to be linked to the perception that research careers afford one's values. We expected individuals—both men and women—who value family flexibility to view research careers as failing to afford their values (*Hypothesis #7*). We do, however, note one caveat. Men who value family have traditionally been able to pursue research careers by marrying women who take on the majority of the family responsibilities. Thus, it is possible that valuing family flexibility will be predictive of women's, but not men's, perception that research careers afford their values.

We next tested hypotheses concerning relations among individuals' (a) occupational values and career value affordances, (b) perceptions of discrimination, and (c) mentor support. The experience of gender discrimination is complex and not well understood. Some work indicates, however, that women who fail to conform to organizational norms are especially likely to be the targets of gender discrimination (Hulett, Bendick, Thomas, & Moccio, 2008). It is possible, therefore, that those women who value having time to devote to their families, and those women who believe teaching careers afford their values, experience greater criticism and less support from their mentors and colleagues than their peers. Thus, we tested the hypothesis that those women who strongly value family flexibility (*Hypothesis #8A*) and perceive teaching as affording their values (*Hypothesis #9A*) are especially likely to perceive women to be the target of gender discrimination within their department.

Relatedly, individuals' occupational values and career affordance ratings may predict their perceptions of their mentor-mentee relationship. Because the goal of research institutions is to train cutting-edge researchers, mentors who become aware that a particular student desires family flexibility, or a teaching career, may invest less heavily in that mentee. This effect is especially likely to occur among female doctoral students. Male academics are more likely than their female peers to have families and to achieve tenure despite having young children, perhaps as a result of spousal support with childcare (Mason & Goulden, 2002; Perna, 2001; Wolfinger, Mason, & Goulden, 2008). Thus mentors of those female (but not male) students who value family flexibility may assume their students will need to sacrifice research productivity in order to raise a family. Although we were unable to objectively assess mentor support, we tested the hypothesis that women's (but not men's) occupational values (*Hypothesis #8B*) and career value affordance ratings (*Hypothesis #9B*) would predict their perceptions of mentor support.

Predicting Students' Satisfaction with Graduate Training

As noted earlier, we assessed doctoral students' occupational values, views of career value affordances, perceptions of gender discrimination, and mentor support because these factors have been cited often as undermining women's pursuit of STEM research careers. Given that we expected gender differences that favored males in each of these domains, we hypothesized that men would report higher levels of satisfaction with their graduate training than women (*Hypothesis # 10*). Additionally, we expected that our major variables would interact with participant gender to predict students' satisfaction with graduate training (*Hypothesis #11*).

With respect to occupational values, Eccles (1983; 1994) and others (Weisgram et al., 2010; Diekman et al., 2010) have linked occupational values to individuals' career pathways, but previous work has yet to look closely at a sample of highly talented and committed STEM students at a major research institution. We expected that those women (but not men) who value family flexibility would be less satisfied with their graduate training (*Hypothesis #11A*). Importantly, graduate programs at research institutions emphasize research training and careers (rather than teaching training and careers). Thus, we also hypothesized that those women

(but not men) who view teaching careers as affording their values—and research careers as *failing* to afford their values—would be less satisfied with their graduate training than their peers (*Hypotheses #11B-C*).

The experience of gender discrimination has also been linked to career satisfaction and persistence in academia (Fouad & Singh, 2011; Settles et al., 2013). Fouad and Singh (2011) found that female engineers who reported experiencing sexism on the job (i.e., who were treated in a condescending and/or patronizing manner in the workplace) were more likely to think about leaving the field than female engineers who did not report these experiences. Of the women with a bachelor's degree in engineering who chose not pursue an engineering career, one third reported the cause to be their perceptions that the field of engineering is "non-supportive" of women. Thus, we expected perceptions of discrimination against women would predict women's (but not men's) satisfaction with their graduate training (*Hypothesis #11D*).

Finally, we expected that—among both males and females—those students who perceived their mentors as highly supportive would be more satisfied with graduate training than their peers who perceived their mentors as less supportive (*Hypothesis #12*).

METHOD

Participants

Participants included 136 doctoral students (59 women, 77 men) in the Department of Chemistry and Biochemistry of a major research-oriented institution in the Southwestern United States. This number represented a participation rate of 45% of the total graduate student population in the department. The sample included 99 European Americans, 4 African Americans, 6 Latinos, 25 Asians or Asian Americans, and 2 Native Americans. Additionally, 23.5% of the participants were international students. Participants ranged in age from 22 to 38 years old ($M = 26.1$, $SD = 2.6$). The average age of women and men did not differ significantly. Two men and three women in the sample were parents.

Overview of the Procedure

Participants were recruited via email notices from the chairperson of the department asking them to complete a survey about their "goals, values, and experiences in their graduate education." Participants completed paper and pencil surveys in a large lecture hall in exchange for pizza and a beverage.

Measures

Demographic characteristics. Participants were asked to report their age, race/ethnicity, gender, area of study, and year in the graduate program.

Occupational values. Participants completed the 16-item Occupational Values Scale (Weisgram & Bigler, 2006). Participants indicated how much they would like a job that afforded characteristics related to one of four values: money (e.g., "I would like a job that allows me to make a great deal of money"), power (e.g., "I would like a job that allows me to have a lot of responsibility"), helping (e.g., "I would like

a job that allows me to be help other people”), and family flexibility (e.g., “I would like a job that allows me to spend a lot of time with my family”). Response options were 1 (“Not at all”), 2 (“Somewhat”), and 3 (“Very much”). Cronbach’s alphas for the four subscales (money, power, helping, and family flexibility) were high: .84, .76, .73, and .74, respectively (George & Mallery, 2006) and similar to those reported by Weisgram & Bigler (2006): .93, .78, .89, and .80, respectively. Each of the subscales met assumptions for normality of the distribution.

Perceived career affordances. Participants rated the extent to which STEM careers within three domains—research, teaching, and industry—would afford the fulfillment of their occupational values. For each career domain, participants responded to the item, “A career [at a research-oriented university; at a teaching-oriented university; in industry] will allow me to fulfill my occupational values,” on a scale ranging from 1 (“Strongly disagree”) to 5 (“Strongly agree”), and thus higher scores indicate greater perceived value affordance for that career.

Perceptions of gender discrimination. Participants rated the frequency with which female and male students experience gender discrimination in their department. Response options ranged from 1 (“Women [Men] never experience gender discrimination in our department.”) to 4 (“Women [Men] often experience discrimination in our department.”).

Perceived mentor support. Participants rated their agreement with three statements about their level of support from their academic mentor: “My mentor advocates (supports/promotes) for me with others when necessary,” “My mentor is sensitive to my needs,” and “My mentor is aware of and shows appreciation of the value that I bring to my research projects and to the research group.” Response options ranged from 1 (“Strongly disagree”) to 5 (“Strongly agree”). Cronbach’s alpha for the scale was .77.

Satisfaction with graduate training. Satisfaction with graduate training was measured using two items. Participants rated their overall satisfaction with their training in the graduate program (“How satisfied are you with your training at [University name]?”) on a scale from 1 (“Highly dissatisfied”) to 6 (“Highly satisfied”), and they rated the frequency with which they think about leaving the program (“How often do you think about leaving the program without your desired degree?”), ranging from 1 (“Daily”) to 6 (“Never”). Responding to the two items was strongly correlated ($r = .54, p < .001.$) and thus responding was averaged across them. Cronbach’s alpha for the two-item scale was .69.

RESULTS

Overview

We began by using multivariate and univariate analyses of variance to test for gender differences on four factors hypothesized to be related to STEM doctoral students’ satisfaction with their graduate training: (a) occupational values, (b) career value affordances, (c) perceptions of gender discrimination, and (d) perceptions of mentor support. We next computed correlations among these variables. Finally, we used hierarchical regression analyses to test our hypotheses

concerning the utility of individuals' occupational values, career value affordance ratings, perceptions of gender discrimination, and perceived mentor support for predicting satisfaction with graduate training. For comparisons about which we had no *a priori* hypothesis, significant *F* tests were followed by post-hoc tests (ANOVAs or *t*-tests, where appropriate) using a Bonferonni-corrected alpha levels. In contrast, *a priori* hypotheses (see Table 1) were tested with planned comparisons across means.

Table 1
Summary of Hypotheses, Analyses, and Results

Hypothesis	Analysis	Outcome
I. Values and Career Value Affordances		
#1. Men and women differ in their occupational values. A. Money: $M > W$ B. Power: $M > W$ C. Altruism: $M < W$ D. Family: $M < W$	one-way (gender) MANOVA	A. supported B. supported C. not supported D. supported
#2. Men and women differ in their perceptions of the degree to which STEM careers afford their values. A. Research career affordance: $M > W$ B. Teaching career affordance: $M < W$	one-way (gender) MANOVA	A. supported B. supported
II. Gender Discrimination		
#3. Men and women differ in their perceptions of discrimination. A. Female students perceive more discrimination towards women than male students. B. Male students perceive more discrimination towards men than female students.	one-way (gender) MANOVA	A. supported B. supported
III. Mentor Support		
#4. Male students perceive greater mentor support than female students.	One-way ANOVA by gender	not supported
#5. Students with same-gender mentors perceive more support than students with other-gender mentors.	One-way ANOVA by gender match	not supported
IV. Relations Among Major Variables		
#6. Students who more strongly endorse (A) money and (B) power rate teaching careers as less strongly affording their values than students who less strongly endorse money and power.	Bivariate correlations	A. supported B. supported
#7. Students who more strongly endorse family flexibility rate research careers as less strongly affording their values than students who less strongly endorse family flexibility.		partially supported
#8. Women who more strongly endorse family flexibility perceive (A) more gender discrimination and (B) less mentor support than women who less strongly endorse family flexibility.		A. not supported B. not supported
#9. Women who more strongly perceive teaching		A. not supported

careers as affording their values perceive (A) more gender discrimination and (B) less mentor support than women who less strongly perceive teaching careers as affording their values.		B. not supported
V. Satisfaction with Graduate Training		
#10. Men are more satisfied with their graduate training than women.	One-way ANOVA by gender	not supported
#11. The interactions between gender and (A) family flexibility values, (B) teaching affordance beliefs (C) research affordance beliefs, and (D) perceptions of discrimination against women predict doctoral students' satisfaction with graduate training.	Hierarchical regression analyses	A. supported B. supported C. supported D. supported
#12. Mentor support significantly predicts doctoral students' satisfaction with graduate training.		supported

Gender Differences Within Predictor Variables

Occupational values. Participants' ratings on the four occupational values subscales (money, power, helping, family) were analyzed using a one-way (participant gender: female, male) multivariate analysis of variance (MANOVA). Means and standard deviations appear in Table 2.

Table 2
Occupational Values by Participant Gender

	Money <i>M (SD)</i>	Power <i>M (SD)</i>	Altruism <i>M (SD)</i>	Family Flexibility <i>M (SD)</i>
Women	2.1 ^a (.47)	1.9 ^a (.47)	2.4 ^a (.42)	2.5 ^a (.46)
Men	2.3 ^b (.55)	2.2 ^b (.47)	2.3 ^a (.45)	2.2 ^b (.39)
Overall	2.2 (.52)	2.1 (.48)	2.4 (.44)	2.4 (.44)

Note. Scores range from 1 ("Not at all important") to 3 ("Very important"). Values within the same column that have different superscripts are significantly different from one another.

Results indicated a significant multivariate main effect of participant gender, Wilks' $\lambda = .84, p < .001, \eta^2 = .16$. Univariate tests revealed that there were significant effects of participant gender on ratings of money, $F(1, 134) = 3.80, p < .05$, power, $F(1, 134) = 8.26, p < .01$, and family, $F(1, 134) = 15.5, p < .001$, but not altruism $F(1, 134) = 1.26, p = .26$. As expected (*Hypotheses #1A-B*), men rated money and power higher than did women. Also as expected, (*Hypothesis #1D*), women rated family flexibility higher than did men.

Career affordances. Participants' ratings of the value affordances of STEM careers within the domains of research, teaching, and industry were analyzed using a one-way (participant gender: female, male) MANOVA. Means and standard deviations appear in Table 3.

Table 3
Career Value Affordances by Participant Gender

	Research <i>M (SD)</i>	Teaching <i>M (SD)</i>	Industry <i>M (SD)</i>
Women	2.8 ^a (1.3)	3.5 ^a (1.2)	3.5 ^a (1.0)
Men	3.4 ^b (1.3)	2.8 ^b (1.2)	3.9 ^a (1.1)
Overall	3.2 (1.3)	3.1 (1.3)	3.7 (1.1)

Note. Scores range from 1 to 5, with higher scores indicating stronger agreement with the statement, "A career in _____ will allow me to fulfill my occupational values." Values within the same column that have different superscripts are significantly different from one another.

Results indicated a significant multivariate main effect of participant gender, Wilks' $\lambda = .82, p < .001, \eta^2 = .18$. Univariate tests revealed that there were significant effects of participant gender on ratings of the degree to which careers in research, $F(1,134) = 5.96, p = .01$, and teaching, $F(1, 134) = 11.8, p < .001$, afford the fulfillment of one's values. As expected (*Hypotheses #2A-B*), men rated research careers as more able to afford their occupational values than did women, whereas women rated teaching careers as more able to afford their values than did men. Women and men did not differ in their ratings of industry careers, $F(1, 134) = 4.65, NS$ (Bonferroni-corrected α cutoff = .017).

Perceptions of gender discrimination. Participants' ratings of the frequency that female and male students experience gender discrimination were analyzed with a one-way (participant gender: female, male) MANOVA. Means and standard deviations appear in Table 4.

Table 4 *Perceptions of Discrimination by Participant Gender and Target Gender*

Participant Gender	Target of Gender Discrimination	
	Women <i>M (SD)</i>	Men <i>M (SD)</i>
Female ($n = 58$)	2.76 ^a (.73)	1.59 ^a (.53)
Male ($n = 76$)	2.26 ^b (.75)	2.04 ^b (.82)

Note. Scores range from 1 ("Never experience gender discrimination in our department") to 4 ("Often experience gender discrimination in our department"). Values within the same column that have different superscripts are significantly different from one another.

Results revealed a significant multivariate main effect of participant gender, Wilks' $\lambda = .80, p < .001, \eta^2 = .20$. Univariate tests revealed that there were significant effects of participant gender on ratings of the frequency with which women, $F(1,132) = 14.5, p < .001$, and men, $F(1,132) = 13.3, p < .001$, experience gender discrimination. As expected (*Hypotheses #3A-B*), female students perceived more gender discrimination against women than did male students. Conversely, male students perceived more gender discrimination against men than did female students.

Perceptions of mentor support. We began by checking whether students were randomly assigned to mentors across gender. A chi-square test of independence revealed that male and female students were distributed non-randomly across male and female mentors, $\chi^2 = 2.70$, $p = .05$; female students were more likely than male students (17% versus 8%, respectively) to have a female mentor.

Ratings of mentor support were analyzed using a 2 (participant gender) by 2 (mentor gender: male, female) ANOVA. Unexpectedly, this test indicated only a significant main effect of mentor gender, $F(1, 134) = 12.38$, $p = .001$, $\eta^2 = .085$. Participants with female mentors reported greater support than participants with male mentors, $M_s (SDs) = 4.42 (.74)$ and $3.41 (1.1)$, respectively. Neither the main effect nor interaction involving participant gender was significant (*Hypotheses #4 and #5*).

Satisfaction with graduate training. We tested for gender differences in overall satisfaction with graduate training using a *t*-test. Contrary to our hypothesis (*Hypothesis #10*), male ($M = 4.59$, $SD = 1.2$) and female students ($M = 4.41$, $SD = 1.2$) did not differ significantly in their ratings of training satisfaction, $t(133) = .85$, $p = .40$.

Correlations Among Predictor Variables

To test our hypotheses concerning relations among the hypothesized predictors of satisfaction with graduate training (see Table 1, section IV), we computed partial correlations between participants' ratings of our four occupational values of interest (i.e., money, power, altruism, and family flexibility), career value affordances (i.e., research, teaching, industry careers), perceptions of gender discrimination towards both women and men, and perceptions of mentor support. Because of the large number of possible predictor variables and the hypothesized interrelations among them, partial correlations were used to calculate the relation between each pair of variables with the influence of the other variables removed statistically (see Stevens, 2009). Intercorrelations for women and men appear in Table 5.

Occupational values and career value affordances. We expected that those individuals who endorsed the stereotypically masculine values of power and money would view teaching careers as failing to afford their values (*Hypothesis #6A-B*). As expected, men and women who endorsed money more strongly perceived teaching careers as less compatible with their occupational values ($r_s = -.20$ and $-.25$, respectively). Furthermore, men and women who endorsed power more strongly perceived teaching careers to be less compatible with their occupational values, ($r_s = -.28$ and $-.27$, respectively).

We also found support for our hypothesis concerning the valuing of family flexibility (*Hypothesis #7*). As expected, women who endorsed family flexibility more strongly perceived research careers to be less compatible with their occupational values ($r = -.20$). Furthermore, men's valuing of family flexibility was unrelated to their perception of research careers as affording their values ($r = .01$).

Table 5

Partial Correlations Among Occupational Values, Career Value Affordances, Perceptions of Discrimination, and Mentor Support

	1	2	3	4	5	6	7	8	9	10
1. Value: Money	-	.43**	.01	.21	.17	-.25*	.34*	-.04	-.07	-.05
2. Value: Power	.35**	-	.38**	-.22	.09	-.27*	-.17	.19	.14	-.08
3. Value: Altruism	-.23*	.29*	-	.16	-.02	.43**	-.13	.29*	-.21	.26*
4. Value: Family	.19	-.15	.29**	-	-.20*	.08	-.01	.06	.07	.04
5. CVA: Research	-.04	.25*	.05	.01	-	.23	-.12	.06	.09	.26*
6. CVA: Teaching	-.20*	-.28**	.27**	-.01	.40**	-	.05	-.04	.04	-.21
7. CVA: Industry	.41**	-.09	-.15	-.19	-.15	.24*	-	.32*	.01	.38**
8. Perceptions of discrimination towards women	-.03	.04	.27*	.01	-.18	-.03	.20	-	.23	-.54**
9. Perceptions of discrimination towards men	-.03	.06	-.21*	-.02	-.01	-.08	-.03	.22	-	.22
10. Perceptions of mentor support	.02	-.21	.17	-.19	.41**	-.19	.08	-.03	-.08	-

Note. CVA= career-value affordance. Correlations for women are above the diagonal, and correlations for men are below the diagonal. Partial correlation coefficients represent the correlation for the pair of variables, controlling for all other variables in the table.

* $p < .05$, ** $p < .01$

Values, career value affordances, and perceptions of gender discrimination.

We next tested the hypotheses that those women who more strongly value family flexibility and perceive teaching careers as affording their values perceive more discrimination against women (*Hypotheses #8A and 9A*). Unexpectedly, neither hypothesis was supported. Neither individuals' valuing of family flexibility, nor their ratings of the degree with which research careers afford their values, were related to perceptions of gender discrimination (see Table 5).

Career value affordances and mentor support. We next tested the hypotheses that those women who more strongly value family flexibility and perceive teaching careers as affording their values perceive less mentor support (*Hypotheses #8B and #9B*). Unexpectedly, neither hypothesis was supported. Instead, the perception of research careers as affording one's occupational values was associated with perceptions of greater mentor support among both men ($r = .41$) and women ($r = .26$).

Perceptions of discrimination and mentor support. Among women, perceptions of greater levels of discrimination toward their own gender (i.e., women) were significantly negatively related to perceptions of mentor support ($r = -.54$). Among men, perceptions of greater levels of discrimination toward their own gender (i.e.,

men) were unrelated to perceptions of mentor support ($r = -.08$).

Predictors of Satisfaction with Graduate Training

Table 6

Hierarchical Regression Predicting Satisfaction with Graduate Training

Variable	B (SE B)	p value	β
Step 1.			
Participant gender	.004 (.25)	.99	.002
Valuing Money	-.09 (.23)	.70	-.04
Valuing Power	.23 (.27)	.41	.09
Valuing Helping	.27 (.27)	.32	.09
Valuing Family	-.17 (.26)	.52	-.06
Research Career Affordance	.06 (.09)	.54	.06
Teaching Career Affordance	-.15 (.10)	.13	-.16
Mentor support	.45 (1.0)	<.001	.40
Discrimination towards ingroup	-.06 (.14)	.64	-.04
Step 2.			
Participant gender	3.2 (1.3)	.01	1.3
Valuing Money	-.10 (.22)	.65	-.04
Valuing Power	.31 (.26)	.24	.12
Valuing Helping	.44 (.26)	.10	.16
Valuing Family	-.58 (.34)	.09	-.20
Research Career Affordance	-.10 (.12)	.39	-.10
Teaching Career Affordance	.05 (.12)	.71	.05
Mentor Support	.39 (.10)	<.001	.35
Discrimination towards ingroup	.14 (.16)	.37	.10
Gender X Family	-1.0 (.48)	.04	-.62
Gender X Research Career	.36 (.16)	.03	.47
Gender X Teaching Career	-.39 (.16)	.02	-.59
Gender X Discrimination towards ingroup	-.61 (.33)	.02	-.70

Note. The interaction terms Gender X Money, Gender X Power, Gender X Helping, and Gender X Mentor Support were not statistically significant. Using backwards elimination, these terms were removed from the final regression model and may be obtained from the authors by request.

Finally, we used hierarchical regression analyses to test our hypotheses concerning the utility of individuals' occupational values, perceptions of gender discrimination, and perceived mentor support for predicting satisfaction with graduate training (*Hypothesis #11A-D*). For perceptions of gender discrimination, we created a variable that indexed students' perceptions of discrimination towards members of their own gender (i.e., female students' perceptions of discrimination against women and male students' perceptions of discrimination against men.). We tested for multicollinearity prior to running regression models. Multicollinearity was not an issue in the model reported here according to tolerance and variance inflation factor (VIF) statistics (VIF < 1.4 and tolerance > .75 for all predictors; see Myers, 1990). To converge on the most parsimonious final regression model, we used a backwards elimination strategy (see Mantel, 1970 and Kutner et al., 2005) for trimming non-significant interaction terms (see Table 6; non-significant terms are

available from the authors upon request).

The complete list of predictors (in the order they were entered) and results of the hierarchical regression model are presented in Table 6. The Step 1 model for satisfaction with graduate training was statistically significant and accounted for 23% of its variance, $F(9, 123) = 4.02, p < .001$. Results of the Step 1 model showed that mentor support was positively related to overall satisfaction with training ($\beta = .40$), such that students who perceived greater levels of support from their mentors reported being more satisfied with their graduate training. None of the other predictors in Step 1 had a significant main effect on satisfaction with graduate training.

In the second step, we tested the effects of the interactions between participant gender and our predictor variables. Adding interaction variables in Step 2 increased the amount of variance explained in training satisfaction to 32%, $F(13, 119) = 4.3, p < .001$. As expected (*Hypothesis #11 A*), the interaction term between gender and valuing family flexibility significantly predicted satisfaction with training ($\beta = -.62$).

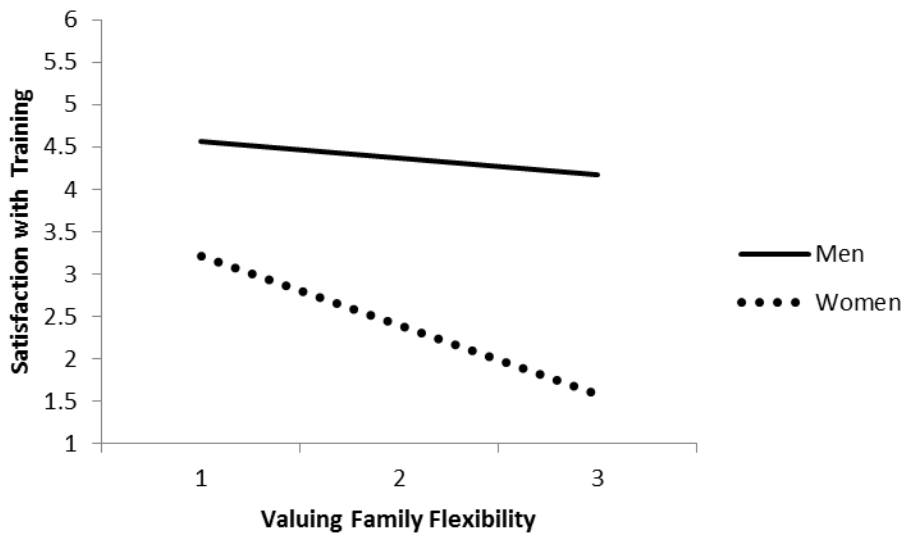


Figure 1. *Satisfaction with training as a function of valuing family flexibility and participant gender.*

As seen in Figure 1, valuing family flexibility was significantly negatively associated with satisfaction with graduate training among women (simple slope¹ = $-.82^*$) but not men (simple slope = $-.20$).

¹ The simple slope is calculated using the regression equation for one predictor at a specific level of a second predictor, and is used in the interpretation of two-way interaction effects in multiple regression (Bauer & Curran, 2005). An "*" indicates that the simple slope is significant

As expected (*Hypothesis #11B*), the interaction between participant gender and teaching career affordance was also a significant predictor of training satisfaction, ($\beta = -.59$). As seen in Figure 2, the perceived affordance of teaching careers was negatively predictive of satisfaction with graduate training among women (simple slope = $-.55^*$) but not men (simple slope = $.05$).

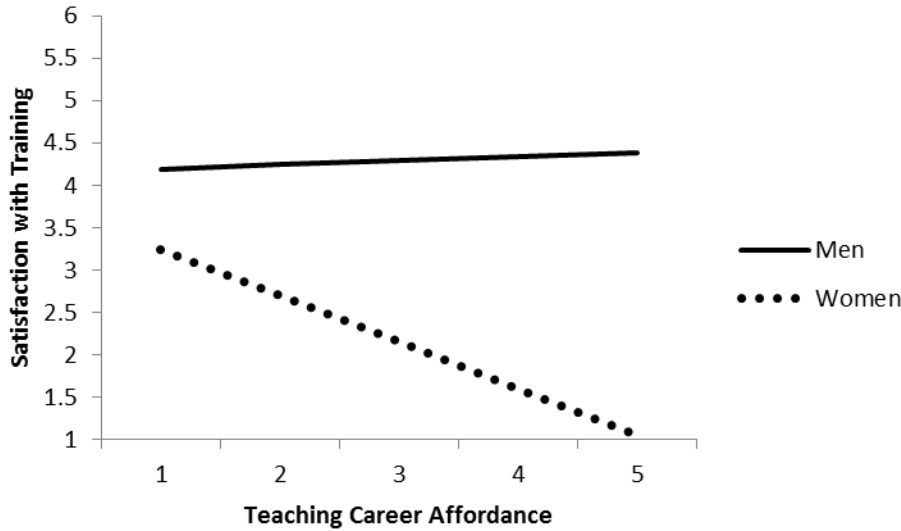


Figure 2. *Satisfaction with training as a function of teaching career affordance and participant gender.*

As expected (*Hypothesis #11 C*), the interaction term between participant gender and research career affordance also significantly predicted satisfaction with training ($\beta = .47$). As seen in Figure 3, the perceived value affordance of research careers was positively predictive of satisfaction with graduate training among women (simple slope = $.37^*$) but not men (simple slope = $-.10$).

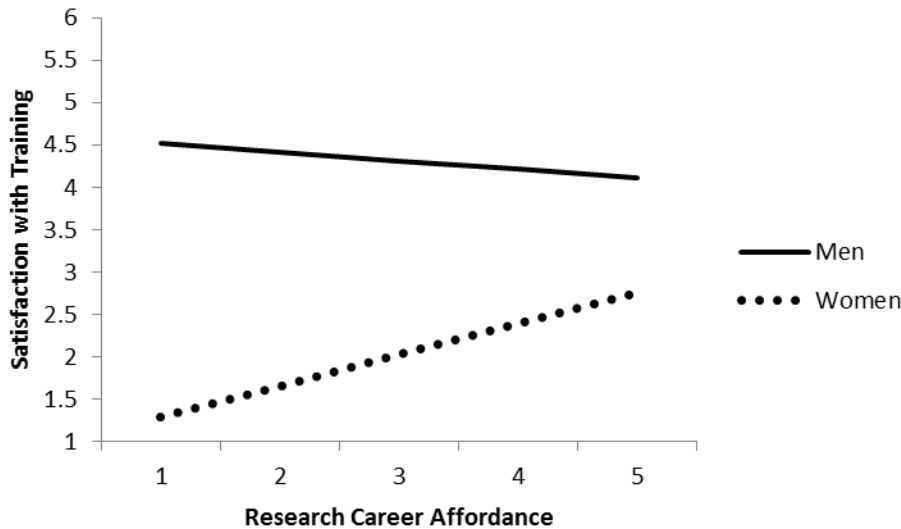


Figure 3. *Satisfaction with training as a function of research career affordance and participant gender.*

Finally, the interaction between participant gender and perceptions of discrimination towards one's ingroup was, as expected (*Hypothesis #11D*), a significant predictor of students' satisfaction with their training, ($\beta = -.70$). As seen in Figure 4, women's satisfaction with graduate training declined as their perceptions of discrimination against women increased (simple slope = $-.61^*$), whereas men's satisfaction with their training was unaffected by their perceptions of discrimination against men (simple slope = $.09$).

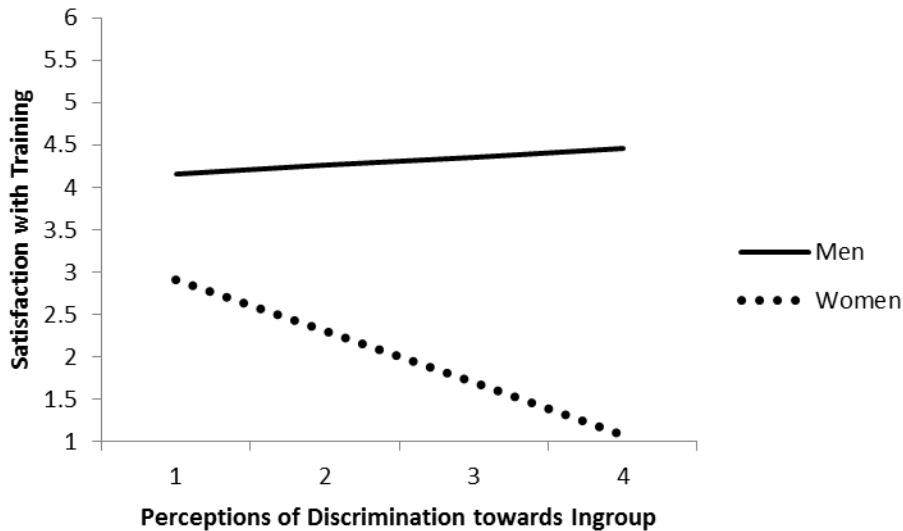


Figure 4. *Satisfaction with training as a function of discrimination towards ingroup and participant gender.*

Note. Scores on the x-axis represent discrimination towards the ingroup. Thus, the scores for men represent perceptions of discrimination towards men, and the scores for women represent perceptions of discrimination towards women.

DISCUSSION

Most STEM fields show a pattern of decreasing representation of women as level of education increases (Goulden, Mason, & Frasch, 2011). Within the field of chemistry, for example, women's representation drops from 50% at the bachelor level, to 46% at the master's level, to 35% at the doctoral level, to 17% at the assistant professor level (Snyder et al., 2009). These data suggest that women's experiences during doctoral training may be critical to their persistence in the field. We examined the hypothesized role of occupational values, perceptions of discrimination, and mentor support in predicting doctoral students satisfaction with their graduate training.

Occupational Values and Career Interests

Recent theoretical and empirical work has highlighted the importance of occupational values in shaping STEM careers (Ceci et al., 2009; Diekmann et al., 2010; Williams & Ceci, 2012; Frome, et al., 2006). We hypothesized that even highly talented and committed STEM students would show gender differences in their occupational values (e.g., money, family flexibility) and perception that STEM careers in research and teaching afford their values. We found support for both of these hypotheses.

Consistent with previous theoretical and empirical work (Eagly & Johnson, 1990; Eagly & Wood, 1999; Goulden et al., 2009), men valued money and power significantly more than did women, whereas women valued family flexibility significantly more than did men. Our data extend past work by documenting the ways in which these broad values shape individuals' view of specific STEM careers. That is, occupational values typically have been used to predict interest *across* disciplines (e.g., STEM vs. business; Diekmann et al., 2010); we expected such values to predict career goals *within* STEM careers. We found that men and women who strongly endorsed money and power perceived teaching careers as less likely to afford their values than their colleagues who less strongly endorsed money and power. Given the status and pay associated with teaching, these findings are unsurprising. Importantly, women (but not men) who strongly endorsed family flexibility perceived research careers as less likely to afford their values than women who less strongly endorsed family flexibility. These data indicate a continuing double standard in which men who value family flexibility perceive research careers as affording the fulfillment of their values, whereas women with similar values do not (Williams & Ceci, 2012; Williams, 2004).

The corpus of available research seems clear: women (as a group), including those women with strong levels of STEM talent and commitment, desire a job that allows them the flexibility to raise a family more so than do men. To increase the numbers of women who successfully pursue STEM research careers, it will be necessary for women to view raising children and such careers as compatible. Two avenues for achieving such a view seem possible. First, men might take on increased levels of childcare responsibility so that women are no longer hindered by family values (paralleling the current situation among male academics). Second, employers, including research institutions, might increase their support for female employees who opt to raise children (Williams & Ceci, 2012). Some research institutions have sought to institute such policies. For example, "sick child care" programs subsidize the cost of hiring a caretaker to stay with a child who is too sick to attend school, with the goal of attracting and retaining female scientists. It will be important for researchers to assess the effectiveness of such policies and programs. It is possible, for example, that an institutional sick child care policy is not perceived as valuing family because most women who value raising children are unlikely to want an unfamiliar person to care for their sick child; they are likely to instead want the freedom to care for their sick child themselves. The presence of "sick child care" program may even backfire—creating an unsupportive environment for working mothers—because it conveys the value (or norm) that mothers of sick children should attend work.

Perceptions of Gender Discrimination

We next hypothesized that women's occupational values would be related to their perceptions of the frequency of gender discrimination within their department. Consistent with previous work (Branscombe, 1998; Swim et al., 2001), female students (more often than male students) perceived women to be the target of gender discrimination. Inconsistent with our expectation, however, correlational data indicated that neither women's valuing of family flexibility nor their ratings of degree to which research and teaching careers afford their values were associated

with perceptions of gender discrimination. In other words, the women in these departments who valued family and viewed teaching—rather than research—as able to afford their values did not show elevated levels of perceptions of gender discrimination. Instead, those women who valued power and altruism perceived more gender discrimination within their department. Although we were unable to collect objective data on gender discrimination, it seems possible that ambitious, status-seeking women—and those women inclined to care deeply helping others—were especially sensitive to gender inequalities in their department.

We also expected that women's occupational values and career value affordance ratings would be related to their perceptions of mentor support. Importantly, this also did not seem to be the case. Those women who valued family flexibility and viewed teaching—rather than research—as compatible with their values perceived their mentors in ways that were equivalent to their peers. These data are encouraging in that they suggest that faculty members are equivalently supportive of students with a broad range of values and goals.

Although individuals' occupational values and career affordance ratings were unrelated to perceptions of discrimination, perceiving a climate of discrimination predicted lower perceptions of mentor support among female students (Hall & Sandler, 1982; Herzig, 2002). This was not true, however, among men. These data are consistent with previous work indicating that experiencing gender discrimination is especially detrimental to women's affect, motivation, and job satisfaction (Schmitt et al., 2002; Settles et al., 2013).

Predictors of Satisfaction with Graduate Training

The final theoretical question addressed here concerned the roles of occupational values, career value affordances, perceptions of discrimination, and mentor support in predicting doctoral students' satisfaction with their training. The large number of significant interaction terms involving participant gender within our regression model revealed that the factors related to satisfaction in graduate school differed among women and men. Again, there was support for the notion that occupational values are important facets of career goals. Those women who strongly endorsed family flexibility were much less satisfied with their graduate training than those women who did not strongly endorse family flexibility. The relation was absent among men. Women who are more satisfied with their graduate training at research-oriented university seem more likely to pursue careers in STEM research, and thus this finding provides additional support for the notion that increases in the number of women who pursue STEM research careers are likely to occur when women perceive these careers as compatible with the desire to raise a family (Williams & Ceci, 2012).

As hypothesized, perceptions of career affordances were also differentially predictive of training satisfaction among women and men. Women who believed that a career at a research institution would afford the fulfillment of their values expressed greater satisfaction with their graduate training than their female peers. The inverse was true of the perceptions of teaching career affordances; women who believed that a career at a teaching institution would afford the fulfillment of their

values expressed less satisfaction with their graduate training than their female peers. The doctoral students in our sample attended a prestigious research institution and thus the finding is somewhat unsurprising. Two points are important to emphasize, however. First, this relation was *not* present among men; their perceptions of the degree to which research and teaching careers would afford the fulfillment of their values were unrelated to their satisfaction with training. In addition, the nature of the causal link between goals and satisfaction is unclear. It is possible that women who become dissatisfied with their graduate training gradually adjust their perceptions of research careers. Alternatively, the reverse is possible; women who come to view research careers as incompatible with their values may become increasingly dissatisfied with their graduate training. Longitudinal data would help to clarify the causal links among these variables.

Finally, the regression analyses revealed that, among all students, the perception that one's mentor values and supports one's research contributions was strongly predictive of satisfaction with graduate training. This finding is consistent with a host of studies demonstrating the critical role of mentoring in graduate student persistence (Tinto, 1993; Herzig, 2002; Herzig, 2004). Importantly, our results showed that the match between mentor and student gender was unrelated to feelings of support; instead both male and female students reported higher levels of support when they had female than male advisors. Although speculative, it is possible that gender differences in the valuing of teaching characterize faculty members as well as doctoral students. Overall, these findings suggest that the addition of female faculty within STEM departments will benefit graduate training among all students (Chandler, 1996).

Limitations and Future Directions

Although these data are suggestive of important gender differences among doctoral students in STEM, some limitations should be noted. Our sample of participants was drawn from a single STEM department (i.e., Chemistry and Biochemistry) within a single research university in the United States. It will be important to determine whether these findings generalize across fields and institutions, as well as across countries. For example, women's experiences with and persistence in STEM fields are likely to vary with the level of government support and implementation of programs aimed at encouraging women to enter STEM fields (Best & Schraudner, 2012). A related limitation is that we do not have longitudinal data for our participants, and thus do not know which students persisted or dropped out over the course of training. As Herzig (2004) has noted, however, attrition at the graduate level is difficult to classify, and much can be learned from examining the experience of women who succeed (rather than fail) in matriculating and obtaining employment and tenure (Etzkowitz, Kemelgor, Neuschatz, & Uzzi, 1992).

Additionally, our perceptions of discrimination data were limited because they did not (a) ask students about their personal experiences with gender discrimination or (b) determine the source or type of gender discrimination. Research has indicated, however, that assessing perceptions of the gender climate in a department are important, even if such perceptions are inaccurate (Settles et al., 2013).

Perceptions of the gender climate, such as perceptions of the amount of sex discrimination in a department, are used by individuals to make decisions about

workplace involvement and commitment, as well as persistence in academic science (Preston, 1994; 2004). Future research should examine the specific types of discrimination experienced by students, especially women, in academic graduate training so that intervention programs might be used to equip faculty and students to address the problem. This is an especially important avenue to pursue because research has demonstrated that both men and women are negatively affected by a workplace climate that is chilly towards women (Miner-Rubino & Cortina, 2004; 2007).

Based on the results of our study, we believe it is imperative that educational policymakers focus on supporting and retaining, rather than merely recruiting, women in STEM fields. Retaining more women at the top of the field is likely to diversify research endeavours and help the U.S. to be competitive in STEM at a global level (Douglass & Edelstein, 2009; U.S. Department of Labor, 2007; Wilson, 1992). Supporting women in their research careers will also help to ensure that the return on the investment of time and energy into their graduate training is maximised.

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