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When Trying Hard Isn't Natural: Women's Belonging With and Motivation for Male-Dominated STEM Fields As a Function of Effort Expenditure Concerns

Jessi L. Smith[1], Karyn L. Lewis[2], Lauren Hawthorne[1], and Sara D. Hodges[2]

Abstract

Feeling like one exerts more effort than others may influence women's feelings of belonging with science, technology, engineering, and math (STEM) and impede their motivation. In Study 1, women STEM graduate students perceived they exerted more effort than peers to succeed. For women, but not men, this effort expenditure perception predicted a decreased sense of belonging, which in turn decreased motivation. Study 2 tested whether the male-dominated status of a field triggers such effort expectations. We created a fictional "eco-psychology" graduate program, which when depicted as male-dominated resulted in women expecting to exert relatively more effort and decreased their interest in pursuing the field. Study 3 found emphasizing effort as expected (and normal) to achieve success elevated women's feelings of belonging and future motivation. Results suggest effort expenditure perceptions are an indicator women use to assess their fit in STEM. Implications for enhancing women's participation in STEM are discussed.

Keywords

gender, science and engineering, belonging, effort, motivation

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> If you are going to discover something new or invent something new, it's a struggle. So I encourage educators to celebrate that, to say: "Who had a fantastic struggle? Tell me about your struggle!"
>
> —Carol Dweck (interview with the American Association of University Women [AAUW], 2010, p. 30)

American women are underrepresented in science, technology, engineering, and math ("STEM" fields; AAUW, 2010). Certainly, progress has been made for women's representation in these fields (Kessel & Nelson, 2011) but the data are clear that from high school, to college, to graduate school and beyond the pipeline is "leaking" women all along the way (Alper, 1993; Halpern et al., 2007). Recent research has emphasized the importance of feeling a sense of belonging within a field as a predictor of success and retention (Dasgupta, 2011; Freeman, Anderman, & Jensen, 2007; Good, Rattan, & Dweck, 2012; Inzlicht & Good, 2006; Walton & Cohen, 2011), and thus it is important to understand factors that may specifically influence women's feelings of belonging and motivation for STEM fields.

Belonging uncertainty arises when one feels unsure of his or her ability to "fit in" within a given academic arena; this doubt can give rise to the feeling that "people like me do not belong here" (Walton & Cohen, 2007, p. 83). Given that women are stereotyped to lack the natural quantitative abilities needed for success in STEM fields—and most women know of these stereotypes (e.g., Nosek, Banaji, & Greenwald, 2002)—women are typically keenly aware of external cues indicating that they might not belong in STEM, such as the numerical underrepresentation of their gender (Murphy, Steele, & Gross, 2007), male-centric physical environments (Cheryan, Plaut, Davies, & Steele, 2009), and even the content of conversations with colleagues (Holleran, Whitehead, Schmader, & Mehl, 2011).

We propose that the perceived amount of effort it takes to succeed may be another important cue influencing women's sense of belonging and motivation to pursue or persist in STEM. However, in this case, the cue comes partially from

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within women themselves, as they interpret the meaning of their effort within STEM fields—an interpretation shaped by the larger societal context in which it occurs, no doubt. We think it is crucial to examine how women perceive the effort they must put in to STEM fields because, as Carol Dweck's quote that opens this article implies, scientists do not often emphasize or celebrate the struggles—the effort—required for making discoveries and achieving success. Indeed, male-dominated fields such as STEM tend to be viewed as requiring "natural talent" for success (Williams & King, 1980), a talent that women are stereotyped as lacking (Nosek et al., 2002). It is assumed that those who have to put forth effort lack innate talent (Cho & Schwarz, 2008; Epstein, 1998; Kiefer & Shih, 2006; Tsay & Banaji, 2011) and women themselves are prone to such effort/ability attribution biases (Sekaquaptewa, 2011). Given that women in STEM fields are hypervigilant for cues that they might not be fitting in (Dasgupta, 2011), we hypothesize that women's feelings of belonging in and motivation for male-dominated STEM fields are damaged by the perception that they are exerting more effort than others even though their objective performance is satisfactory—and equivalent to that of men's.

Perceptions of effort in STEM fields are likely intertwined with assumptions about what it means to be intelligent in these fields, and such assumptions are prone to gender stereotypes (Eccles, 1984; Erdley & Dweck, 1993). For example, parents view their daughter's success in masculine fields such as math as a result of her effort, but their son's success in these same fields as a result of his natural talent (Eccles et al., 1993). These assumptions about how intelligence is achieved can be characterized as "incremental" or "entity" (see Murphy & Dweck, 2010). Women are often assumed to achieve success through effort (e.g., Raty, Vanska, Kasanen, & Karkkainen, 2002), and this incremental theory views intelligence as malleable (e.g., Grabill et al., 2005). The expectation that women achieve intelligence through effort, however, does not match with "entity" theories of intelligence commonly associated with STEM fields (Good et al., 2012; Yee & Eccles, 1988) that view intelligence and ability as a fixed quantity; such a mismatch can be problematic. For instance, Good and colleagues (2012) followed college undergraduates taking an advanced math course and measured their sense of belonging in math longitudinally over the semester. Both women and men who perceived high levels of entity messages in the environment felt a lower sense of belonging to math, but this relationship was especially pronounced among women who also perceived high levels of math gender stereotyping in the environment.

One puzzling (and recurring) finding is that despite qualifications similar to or better than those of their male peers, women are more likely to doubt their abilities in math and science (e.g., Ehrlinger & Dunning, 2003; Else-Quest, Hyde, & Linn, 2010; Spelke, 2005; Steffens & Jelenec, 2011). Evidence from social comparison research has shown that uncertainty regarding the self can lead to more frequent social comparisons (Buunk & Ybema, 1997; Hogg, 2000). Given that observers associate high effort with low competence (Kiefer & Shih, 2006; Nicholls, 1984; Tsay & Banaji, 2011), and that male-dominated fields are frequently stereotyped as requiring fixed natural abilities to succeed, perception of effort expenditure seems a likely dimension on which women uncertain about their status in STEM fields would compare themselves with peers. In male-dominated fields especially, women attribute poor performance to a lack of their underlying ability (Felder, Felder, Mauney, Hamrin, & Dietz, 1995). These findings suggest that women may be examining indicators other than actual objective performance to gauge whether they can be successful in STEM fields. We hypothesize that effort expenditure is one such indicator that women use to assess their abilities and evaluate their fit in these domains. We predict that women's perceptions that they exert greater effort than others reduce their belonging and motivation to pursue and persist in STEM. In contrast, we do not expect that men's perceptions of their effort expenditure will necessarily influence their feelings of belonging with or motivation for STEM.

In these studies, we focus on the experience of women enrolled in STEM graduate programs and on expectations associated with considering a (fictional) graduate program. Graduate-level experiences are relatively understudied. The little empirical work that does exist suggests that female STEM graduate students report being highly concerned with the competitive academic environment (Moyer, Salovey, & Casey-Cannon, 1999) and are judged by faculty members as being less committed to their program (Ellemers, Van den Heuvel, de Gilder, Maass, & Bonvini, 2004). The current project, therefore, contributes to what is known about STEM participation at the graduate level, where students' feelings of belonging uncertainty may manifest in different ways and lead to somewhat different outcomes than those found among undergraduates. For example, the concept of belonging uncertainty was developed with undergraduate students (e.g., Walton & Cohen, 2007), and undergraduates who feel like they do not fit in or belong—particularly those who are members of groups that are underrepresented in a field—may express disinterest in their major course of study (Cheryan et al., 2009; Cheryan & Plaut, 2010) or ultimately change majors (e.g., Seymour & Hewitt, 1997). However, being part of a STEM graduate program renders these responses to belonging uncertainty less likely. It is doubtful that a graduate student would (or could) simply "switch" his or her graduate program of study as easily as an undergraduate student.

Project Overview

The goals of this project were to test (a) whether women in graduate STEM programs expect they will have to exert more effort than peers to succeed, (b) whether such effort expenditure comparisons are associated with a decreased

sense of belonging for women but not men, (c) whether expectations about exerting comparatively more effort occur more often in male-dominated graduate fields, and if so, (d) whether such effects can be countered by emphasizing that exerting effort is normal. We started by testing whether women (but not men) would perceive themselves as exerting comparatively more effort than their peers in typically male-dominated fields by surveying first-year graduate students in STEM fields (Study 1). We followed this up by presenting a novel science master's program in "eco-psychology" (about which participants should have no preconceived stereotypes or notions) to men and women early in their college career (Study 2) and to advanced undergraduate women who were close to graduation (Study 3). We also manipulated the characterization of eco-psychology as male-dominated or gender-equal (Study 2) and manipulated feedback about effort requirements to succeed in the novel graduate program (Study 3). Across studies, we measured perceptions of effort expenditure and motivational outcomes. In Studies 1 and 2, we compared women's experiences to men's and in Study 2 we also included a comparison between men's and women's perceptions of a male-dominated versus gender-equal science field. Study 3 examined women's perceptions of a male-dominated field and compared the effect of various effort-related messages about the field.

Study 1

Method

Participants and procedure. A total of 149 first-year STEM graduate students (75 women) enrolled at either the University of Oregon (UO; n = 81) or Montana State University (MSU; n = 68) participated in this study. STEM fields were defined by National Science Foundation guidelines and included graduate programs in the following areas (percentage of the sample in each discipline follows in parentheses): biochemistry (8.1%), biology (8.1%), chemistry (12.1%), computer science (9.4%), earth science (12.1%), environmental science (6.7%), engineering (18.8%), mathematics (12.8%), and physics (12.1%).

A list of all first-year graduate students in the STEM fields was obtained from the registrar on each campus. From this list, all female students and a roughly equivalently sized random sample of male students were contacted through a letter delivered via campus mail. This letter gave a brief description of the study and provided a URL and password to access the survey online. Reminder emails containing the same information were sent approximately one to three weeks later. In exchange for participation, all students were offered a US$15 gift certificate to their campus book store. Response rates were slightly higher at MSU (MSU: 59.8%; UO: 46.2%).

Measures. Effort expenditure comparison was assessed with four items created for this project: "Compared with other students, how much effort do you expend in your field of study?"; "Compared with other students, to what extent to do you find the material and work in your field challenging?"; "Compared with other students, to what extent does your field come easily and naturally to you?" (reverse scored); and "Compared with other students, how much energy does it take you to succeed in your field?" The items were measured on 5-point Likert-type scales (1 = *a lot less*, 5 = *a lot more*) and had good inter-item reliability (Cronbach's α = .78), so items were averaged to form a composite effort expenditure comparison variable.

In addition to assessing effort expenditure comparative ratings via self-report, we also asked participants to make absolute ratings of their own effort and to make absolute ratings of the efforts of a specific peer of their choosing. Three items assessed participants' absolute ratings of themselves on 5-point Likert-type scales: "How much energy does it take you to succeed at your field?", "How much effort do you expend in your field?", and "To what extent does your field come easily and naturally to you?" (reverse scored). After completing absolute ratings for the self, participants were asked to bring to mind a specific student in their same incoming class and to report this person's first initial and gender. Then participants completed three parallel items that assessed absolute ratings of the specific peer on 5-point Likert-type scales: "It takes a lot of energy for ____ to succeed in this field.", "____ expends a lot of effort in this field.", and "This field comes easily and naturally to _____" (reverse scored).

A subset of items from the academic fit measure used by Walton and Cohen (2007) and the College Satisfaction and Persistence Scale (Cabrera, Castaneda, Nora, & Hengstler, 1992) were used to measure belonging. These six items ("I feel I belong within my department," "I am confident I made the right decision in choosing my program," "I am satisfied with my academic experience," "It is likely that I will reenroll at this university next fall," "I feel comfortable at the UO/MSU," and "People at the UO/MSU accept me") were assessed using 7-point Likert-type scales (1 = *strongly disagree*, 7 = *strongly agree*).[1] These items had good inter-item reliability (α = .77) and were averaged to form a composite variable.

To assess participants' motivation for their specific STEM field, we used 25 domain motivation items (see Smith, Sansone, & White 2007; for example, "Doing work in _____ is important to me.", "I care very much about how well I do in _____.", "I would like to do work related to _____ in the future.") that were tailored to the participants' self-reported graduate program and uses a 7-point Likert-type scale (1 = *strongly disagree*, 7 = *strongly agree*). These items had good inter-item reliability (α = .91) and were averaged to form a composite variable.

To assess objective performance, we also asked participants to report their grade point average (GPA) from the previous term. Although not a perfect measure of actual

Table 1. Correlations and Descriptive Statistics for Study 1 Measured Variables Separately for Women and Men

	1	2	3	4
1. Effort expenditure comparison	—	.07	.06	–.40*
2. Academic belonging	–.29*	—	.52*	.08
3. Domain motivation	–.23*	.65*	—	.06
4. GPA	–.23*	.43*	.23*	—
Women's *M* (*SD*)	3.36 (0.70)	5.95 (0.76)	6.06 (0.49)	3.70 (0.35)
Men's *M* (*SD*)	2.99 (0.77)	5.58 (0.94)	5.90 (0.56)	3.62 (0.42)

Note: GPA = grade point average. The correlations for women (n = 75) are below the diagonal of the matrix; the correlations for men (n = 74) are above the diagonal.
*p < .05.

performance, there is evidence that self-reported GPA does adequately correlate with actual GPA (Cassady, 2001).

Results

Data analytic strategy. Our primary hypothesis for this study was that women in STEM fields would perceive they were exerting more effort than their peers, whereas men would not. We also hypothesized that effort expenditure comparisons are a dimension that women (but not men) use to evaluate their academic fit so we expected that this variable would be negatively related to academic belonging for women but unrelated for men. Consistent with past research (Dasgupta, 2011; Good et al., 2012; Walton & Cohen, 2011), we also expected that academic belonging would in turn affect motivation within a domain. Thus, our hypothesized process involves a mediation model that is moderated by participant gender. To test our hypotheses, we compared model fit in a constrained model where all path estimates were forced to be equal for men and women to the fit for less restricted models where path estimates were allowed to vary for men and women. Improvement in model fit when constraints are lifted indicates that the path in question differs for men and women. (It is important to note that although we tested for the proposed mediational model, all measures in this study were collected at a single time-point so these correlational data can only suggest but not confirm causal processes.)

Primary results. Table 1 presents the zero-order correlations among all measured variables as well as their means and standard deviations separately for women and men. Before analyzing the hypothesized mediation model, we first tested whether women and men differed on the measured variables even when controlling for performance (i.e., self-reported GPA). To do this, we ran separate one-way ANCOVAs on the measured variables with participant gender as a between-subjects factor and GPA as a covariate. Notably, there were no gender differences in self-reported GPA, $F(1, 140) = 1.59$, $p = .21$, and if anything, women ($M = 3.70$) reported a slightly higher GPA than men ($M = 3.62$).

As predicted, women, more so than men, reported expending comparatively more effort than peers, $F(1, 140) = 12.73$, $p < .01$, $R^2 = .08$. Domain motivation did not differ between men and women, $F(1, 140) = 3.00$, $p = .09$, $R^2 = .02$, and surprisingly, men reported significantly less academic belonging than women, $F(1, 140) = 5.90$, $p = .02$, $R^2 = .04$. These data suggest that first-year female graduate students in STEM are not necessarily starting out with lower levels of belonging than men (a result consistent with findings by Good et al., 2012). However, our key question was not whether women perceived lower belonging, but whether women's feelings of belonging may be determined by effort comparison concerns, and whether belonging may in turn predict women's motivation for STEM. We turn to this question next.

As shown in Figure 1, we predicted that for women, perceptions of expending more effort would be negatively related to academic belonging, which in turn would be positively linked to domain motivation. Thus, we expected the effect of effort expenditure comparison concerns on domain motivation would be mediated by academic belonging. We further predicted that effort expenditure comparison concerns would only be linked to academic belonging for women.

Figure 1 displays the path estimates (unstandardized regression coefficients) from the unconstrained model (i.e., where all paths were estimated separately for men and women). As hypothesized, results showed that effort expenditure comparison concerns were negatively related to academic belonging ($b = –0.31$, $p = .01$) for women but not for men ($b = 0.08$, $p = .56$). Consistent with past research, academic belonging was related to domain motivation for both women ($b = 0.41$, $p < .01$) and men ($b = 0.32$, $p < .01$). The indirect effect of effort expenditure comparison concerns on domain motivation was significant for women ($b = −0.13$, $p < .01$) but not for men ($b = 0.03$, $p = .69$).[2]

Providing further support of our hypothesis that this mediational model was moderated by gender, constraining the path between effort expenditure comparison concerns and academic belonging to be equal for men and women significantly decreased model fit, $\chi^2_{\Delta}(1) = 4.44$, $p = .04$. Thus, the best-fitting model was one where path b (the path between academic belonging and domain motivation) was constrained to be equivalent for men and women, but path a (the path between effort expenditure comparison concerns and

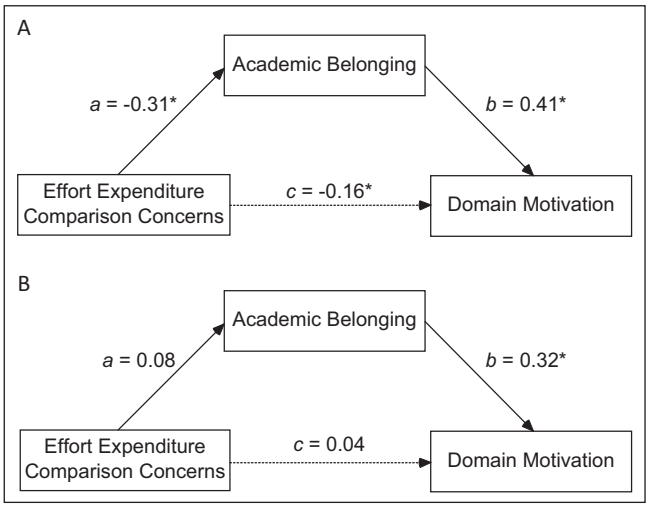

Figure 1. Hypothesized mediation model results separately for women (A) and men (B)
Note: All coefficients are unstandardized parameter estimates from the unconstrained model.
*p < .05.

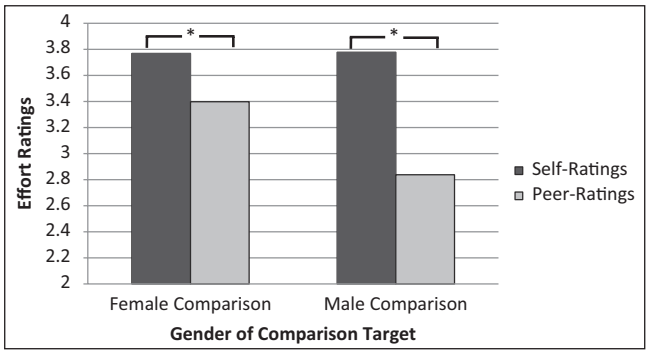

Figure 2. Women's self- and peer-effort ratings as a function of the gender of the comparison peer target
*p < .05

academic belonging) was estimated separately for men and women, $\chi^2(3) = 2.691$, $p = .44$, root mean square error of approximation (RMSEA) = .00.

In a simpler model without academic belonging, effort expenditure comparison concerns were negatively related to domain motivation ($b = -0.16$, $p = .04$) for women but not for men ($b = -0.04$, $p = .64$). Thus, for women, it was possible to test whether academic belonging fully or partially mediated the relation between effort expenditure comparison concerns and domain motivation. Using the women's data only, we compared model fit for a model that freely estimated a direct path from effort expenditure comparison concerns to domain motivation to one where this path was constrained to 0 (both models included the indirect path through academic belonging). Consistent with full mediation, constraining this path to be 0 did not significantly worsen model fit, $\chi^2(1) = 0.31$, $p = .58$.

Secondary results. The effort expenditure comparison variable in the above analyses was participants' comparative judgments about how much effort they exerted relative to "other students" generally. However, it is possible that different processes are implicated if women view the relevant comparison standard as predominantly out-group peers (men) rather than in-group peers (other women). Although we believe that women viewing themselves as expending more than average effort is problematic regardless of who they view as relevant comparators, we wanted to know if our results held whether women compared themselves with male peers (who would be more cognitively available due to the stereotypically male nature of STEM fields) or other women. To this end, we first analyzed whether men and women picked similar comparison targets when asked to consider a specific peer in their incoming class. Men were more likely to pick other males as comparison targets (83.8% of the time), whereas women were roughly equally as likely to select females (48% of the time) or males (52% of the time), $\chi^2(1) = 17.23$, $p < .001$.

Because women were equally likely to pick male and female peer targets, it was possible to test whether the difference between women's ratings of a specific peer's effort and their own effort depended on the peer's gender. Thus, for female participants, we aggregated the absolute effort items to form a composite effort score for the self-ratings and a composite effort score for the selected peer ratings. We then ran a mixed ANOVA on female participants' composite absolute effort ratings with gender of the peer selected for comparison as a between-subjects factor (male peer vs. female peer) and target of ratings as the within-subjects factor (self-ratings vs. peer-ratings). This analysis revealed a main effect of target of ratings, $F(1, 73) = 33.36$, $p < .01$, $R^2 = .29$; overall, women rated themselves as exerting more effort than the specific peer they brought to mind.

We did not expect the absolute self-ratings to differ for women who picked a male peer versus a female peer, and indeed they did not, $t(73) = 0.07$, $p = .94$. However, we thought it possible that the *difference* between women's self-ratings and peer-ratings might vary depending on the gender of the peer comparison target. As seen in Figure 2, this prediction was confirmed by a significant interaction effect. There was a larger discrepancy between self- and peer ratings when women compared themselves with a specific male peer versus a specific female peer ($M_{\text{difference}} = .37$ and .94, respectively), $F(1, 73) = 6.31$, $p = .01$, $R^2 = .05$. However, simple effects tests confirmed that self-ratings were significantly different from other-ratings in both cases—female peer: $t(35) = 2.11$, $p = .04$ and male peer: $t(38) = 6.45$, $p < .01$.[3]

Together, these results suggest that this sample of female STEM graduate students perceived that they must exert more effort than their peers to succeed in their graduate program regardless of whether they were thinking of other students in general, or whether they brought to mind a specific peer of

either gender. However, comparisons with specific peers suggest that women particularly view themselves as having to expend more effort when they bring to mind a male peer.

Discussion

We found that women in STEM graduate programs were more likely to report feeling as if they expend comparatively more effort than their peers. Furthermore, for women only, these feelings were related to a decreased sense of academic belonging. Perceptions of expending comparatively more effort were negatively related to domain motivation in participants' chosen STEM field, but again only for women, and the effects of these effort comparison concerns were fully mediated by feelings of academic belonging. Thus, women who perceived they were expending more effort reported feeling less belonging, which was in turn related to lower motivation for their field of graduate study.

The finding that men reported lower overall levels of belonging was unexpected, as several scholars suggest that women should feel more belonging uncertainty in STEM fields than men (e.g., Dasgupta, 2011). However, women do not always report lower belongingness in STEM fields (nor do other groups that are minorities in academic settings more generally—see Walton & Cohen, 2007). For example, Walton, Cohen, Cwir, and Spencer (2012) found no gender differences in an experiment examining sense of social connectedness to math. Similarly, Good et al. (2012) surveyed male and female students in an advanced math course at three time-points. Interestingly, within this sample of highly talented math students, results yielded only very modest evidence for gender differences in sense of belonging, with the researchers finding nonsignificant gender differences in sense of belonging to math at two of the three time-points ($d = -.10$ at the beginning and $d = .01$ at the end of the semester) and a small effect favoring men ($d = -.14$) at Time 2 (the middle of the semester). However, men and women in this study *did* differ in terms of how their sense of belonging predicted important outcomes. For men, their initial sense of belonging to math at the beginning of a course predicted their intent to pursue math further after the end of the course. However, for women, their *change* in sense of belonging over the course of the term predicted their future intent to pursue math.

Thus, mean levels of belongingness in STEM may not always differ between men and women, but an interesting picture is emerging about how women's sense of belonging and motivation in these fields may be influenced differently than men's, and these differences may help explain why women leave these fields. Furthermore, women also are more likely than men to desire and maintain a more interdependent sense of self (Cross & Madson,1997); are more likely to "tend and befriend" under times of stress (Taylor, 2006); and typically endorse more interpersonal work goals (Morgan, Isaac, & Sansone, 2001). These qualities suggest that women may desire and seek out more belonging in their fields than men, and possibly that belonging levels that are merely equal with men's may not be "good enough" for women.

It is also the case that past research on belonging has typically been conducted with undergraduate participants at early stages in the STEM pipeline. Because the women in our sample had likely first completed a STEM-related undergraduate degree and then gone on to gain acceptance into competitive STEM graduate programs, their belongingness might be influenced by the fact that they had made it this far into the pipeline. Our results are among the first to systematically assess belonging uncertainty among graduate-level STEM students and thus, additional research is needed to see whether this pattern of greater belongingness replicates among female STEM graduate students. However, regardless of mean levels of belonging, belonging appears more tenuous for individuals whose identity is stigmatized in a particular context (Inzlicht & Good, 2006) and is a strong predictor of retention for stigmatized individuals (Walton & Cohen, 2011). In light of this, what is important and most concerning about Study 1's findings is that the perception of exerting comparatively greater effort than others was linked to less academic belonging and ultimately less domain motivation for women. In contrast, for men, perceptions of exerting comparatively greater effort were unrelated to belonging or domain motivation.

Study 2

The results of Study 1 provided initial support for the hypothesis that female graduate students in STEM feel that they expend more effort compared with other students in their program. It did not appear that women were exerting more effort because they had lower ability in STEM fields, as women and men reported similar GPAs. Indeed, if anything, women are more likely than men to underestimate their achievements (e.g., Stout, Dasgupta, Hunsinger, & McManus, 2011) likely due in part to the gender-related modesty norm and the accompanying fear of backlash for self-promoting (e.g., Moss-Racusin & Rudman, 2010). However, it is important to note that women who self-select into STEM graduate programs are necessarily different from those who drop out or do not opt into these fields in the first place. Women who enroll in graduate STEM programs may have unique experiences with male-dominated fields and/or have different resources for contending with pre-existing gender stereotypes. Culturally specified stereotypes about STEM fields that suggest that these fields do not value effort, that they are male-dominated, and that they are more appropriate for men likely resulted in a number of women self-selecting into other fields prior to entering graduate school (Correll, 2004). The goal of Study 2 was to experimentally test whether elevated expenditure concerns were more likely among women than men in male-dominated graduate science fields. To do this, we created a fictitious "eco-psychology" gradu-

ate program. We asked participants to separately report their own anticipated level of effort expenditure in "eco-psychology" and the anticipated level of effort expended by the "average" student.

Method

Participants and procedure. Introductory psychology students at MSU (N = 92, 53% women, 86% Caucasian, mean age = 20.4 years) participated in exchange for course credit. Approximately 22.2% of participants majored in a STEM field, 17.8% majored in the social sciences, 31.1% majored in a health-related field, and the rest had a variety of other majors. Participants were blocked on gender and randomly assigned to either a male-dominated depiction of eco-psychology or a gender-equal depiction (described below).

Participants read one of two brochures for an "accelerated one year master's program that may soon be offered in eco-psychology." Eco-psychology was described as "integrating ecology and psychology—among its contributions are bringing psychological principles and practices to environmental education and action, bringing the contributions of ecological thinking and the values of the natural world to psychology and mental health, and fostering lifestyles that are both ecologically and psychologically healthy." The brochure ostensibly came from the University of Colorado (UC) at Boulder (chosen for its environmentally progressive reputation) and was made to look very professional. Participants were led to believe that MSU was considering adopting a similar graduate program. After examining the brochure at their own pace, participants completed a rating packet.

Materials and Measures

Manipulation of eco-psychology graduate program gender composition. The brochures described the coursework, faculty, and job and internship opportunities ostensibly provided by the program at UC at Boulder. Similar to Murphy et al. (2007), we created a male-dominated condition and a gender-equal condition. In the male-dominated condition, the brochure gave a list of faculty with primarily male names and the majority of the photographs in the brochure were of men. In the gender-equal condition, the faculty was evenly composed of men and women's names, and the pictures showed equal numbers of men and women along with gender neutral items such as campus buildings. The brochures were identical in all other aspects.

Pilot testing with 37 psychology undergraduate students (59% women) showed the male-dominated brochure was rated as masculine (M = 2.0, SD = 1.29, on a scale of 1 "masculine" to 5 "feminine"). This mean differed from the scale midpoint of 3, which was labeled gender neutral (one sample t test, $p < .05$), whereas ratings of the gender-equal brochure did not differ from the scale midpoint (M = 2.8, SD = .91, p = .24).

Effort ratings. Embedded in an overall "Evaluations and Opinion" packet, participants were asked to rate on 5-point scales (higher numbers indicated more effort) how much effort would be required of them to succeed in eco-psychology (5 items, $\alpha = .70$, sample item: "How much effort do you think *you* would need to expend in the eco-psychology program?"); and how much would be required of the "average" student (5 items, $\alpha = .73$, sample item "How much effort do you think the *average student* would need to expend in the eco-psychology program?"). We calculated the difference between self and average student ratings, for an overall effort comparison discrepancy score (with higher numbers indicating that participants thought they were exerting more effort than the average student).

Future interest ratings. To assess future interest in pursuing the eco-psychology graduate program, participants completed three items modeled after those used by Smith and colleagues (2007), including, "How willing would you be in the future to apply to a master's in eco-psychology program like the one described in the brochure?" ($\alpha = .96$). Future motivation items were rated on a 7-point scale, with higher numbers indicating greater interest.

Results and Discussion

Effort ratings. We conducted a 2 (women vs. men) × 2 (brochure: male-dominated vs. gender-equal) ANOVA on the effort comparison discrepancy scores. Analyses yielded an interaction between participant gender and brochure condition on the difference in perceived effort required for the self to succeed compared with the effort required for the average peer to succeed, $F(1, 85) = 7.3$, $p < .01$, $R^2 = .15$. As predicted, women in the male-dominated brochure condition expected they would need to exert more effort than their peers to succeed, but this was not the case for men in the same condition, $F(1, 85) = 8.46$, $p < .05$, or for either men or women in the gender-equal condition, $F(1, 85) = 11.50$, $p < .01$. Men's effort comparison discrepancy scores did not differ by condition (see Table 2). Thus, women who saw the male-dominated characterization of eco-psychology inferred that eco-psychology would require more effort from them than their peers.

Future interest ratings. A 2 (women vs. men) × 2 (brochure, male-dominated vs. gender-equal) ANOVA was conducted on ratings of future interest (see Table 2 for descriptive statistics). Analyses again yielded an interaction between participant gender and brochure condition on amount of future interest in pursuing eco-psychology, $F(1, 86) = 5.67$, $p < .02$, $R^2 = .16$. Paralleling results for effort expenditure expectations, simple effect analyses (see Table 2) indicated that women given the male-dominated brochure reported the lowest levels of future interest in pursuing eco-psychology compared with participants in all of the other conditions ($p < .001$). Importantly, women in the gender-equal condition did not differ from men in either condition, and men's motivation ratings were unaffected by brochure condition.

Table 2. Study 2 Descriptive Statistics and Analyses by Condition

	Type of brochure viewed			
	Male-dominated		Gender-equal	
Gender of participant	*M*	*SE*	*M*	*SE*
Effort for self versus average student discrepancy				
Men	$-.15_b$	.23	$-.00_b$	.19
Women	$.72_a$	.19	$-.25_b$	.21
Future interest (1-7 scale)				
Men	3.19_b	.22	3.30_b	.18
Women	2.53_a	.18	3.58_b	.22

Note: Means not sharing a subscript are statistically significantly different at $p < .05$ as determined using Simple Effect Analyses.

Summary. Results suggest that women who viewed the male-dominated description of the eco-psychology graduate program inferred that they would have to exert more effort than the hypothetical average student; when the same field was presented as gender-equal, women's effort expenditure expectations were lower (and did not differ from that of men's in either condition). In other words, the only group who thought they would have to exert more effort than average was women who saw the field as male-dominated. Moreover, women in the male-dominated condition reported being less interested in pursuing this program compared with women in the gender-equal condition and men in either condition. Because the field was fictitious, these effects are unlikely to be confounded with preexisting stereotypes about or experiences in the field.

Study 3

In Study 2, we demonstrated that portraying a science field as male-dominated made women expect that they would have to exert more effort than the average student and resulted in women reporting less interest in pursuing the field. In Study 3, we explored ways to counteract these effects by manipulating women's perceptions of how success is achieved. Specifically, Study 3 was designed to test whether normalizing effort by emphasizing that *everyone* has to put forth high effort to succeed could buffer women's motivation and feelings of belonging in STEM fields. Such an attempt to reframe academic struggles and adversity as "common" has successfully enhanced stigmatized students' feelings of belonging (Walton & Cohen, 2011). For comparison purposes, we also included a no-information control condition, a condition in which participants were told that success would be achieved by putting in more effort than others, and a condition where they were told success would be achieved by relying on natural ability.

Study 3 varied in a few other key respects. In contrast to the first and second year college student participants in Study 2, we selected female juniors or seniors for Study 3 under the assumption that postgraduate plans would be more salient to this group (similar to Carroll, Shepperd, & Arkin, 2009). We also selected participants with an interest in either psychology or ecology and included additional measures of expectations and motivation.

Method

Participants. Women MSU undergraduates ($N = 48$, 75.6% Caucasian) classified as junior or seniors ($M_{age} = 21.97$ years) were asked to participate in exchange for a US$10 giftcard to the university bookstore. Participants were recruited from several upper-division ecology and psychology classes and were told that the administration was interested in adding a (fictitious) new "eco-psychology" graduate program, and that we were obtaining student feedback on the program. Data were excluded from one participant due to experimenter error and from six others who reported suspicion, resulting in a total of 41 participants. Approximately 47.5% of participants majored in psychology, 17.5% majored in a STEM field, 15% majored in a health-related field, and the remaining 20% were in a variety of other majors. Participants were run individually and were randomly assigned to one of four expectation conditions (described below).

Procedure

We borrowed heavily from the procedure of Carroll et al. (2009) who created a fictional "business psychology" master's program for their study (see also Correll, 2004). A female research assistant greeted the participant and explained that the purpose of the study was to provide information and gauge student opinion about a one-year master's program in "eco-psychology" that the university's division of graduate education was interested in adopting as well as to "recruit viable candidates for enrollment in the program." Participants were led to believe they were interacting with the "advisor" of eco-psychology at the UC at Boulder via webcam, which was the program MSU had been planning to model. In reality, the videos were prerecorded. Participants were then given the male-dominated brochure used in Study 2 to review.

At this time, the female experimenter "noticed" that the microphone was not working and went into the other room and engaged in a simulated conversation with a male research assistant to inquire about how to proceed. This conversation was enacted to explain why participants would be unable to speak with the advisor during the session. The female experimenter then reentered the main room and explained that the advisor would not be able to hear them, but that they would be able to hear the advisor.

The participant then watched a 6-min video (again, modeled after Carroll et al., 2009) in which the advisor (a White male psychology professor) introduced himself and described the eco-psychology program in depth. Next, the participant completed an ostensible "career inventory" that would be "transmitted electronically to examine and determine the participant's program eligibility." This inventory included overall GPA as well as other filler items used to bolster the believability of the expectation manipulation (described below). After finishing the inventory, participants were prompted to "reconnect" to the advisor's satellite feed; at this point, a preprogrammed error message appeared stating that the computer was unable to connect. The female experimenter then gave a cue to the male research assistant in the other room who used a cell phone to call the laboratory phone. The experimenter in the other room then "answered" the ringing phone and simulated a conversation with the advisor (that was easily overheard) regarding the lost satellite connection. The point here was to make it seem as if the advisor was asking the experimenter in the other room to give a message to the participant. After ending the conversation, the experimenter then went into the main room and explained to the participant that the advisor had called and asked to give the participant a message regarding her eligibility for the program. In this way, the main experimenter remained blind to condition. The phone message served as our manipulation of effort expectations.

Manipulation of expectations. The experimenter from the other room who ostensibly spoke with the advisor in Colorado randomly assigned participants to condition by handing them one of four messages that constituted the expectation conditions. Each handwritten message began: "Given your GPA of [participant's GPA was listed here] and your responses to the inventory, you are a good candidate and would likely succeed." In the *no information control condition*, this was the entire message. For the other three conditions the messages all continued, "But know to achieve this success . . . you would have to rely on your natural ability" (*natural ability condition*); or "you would likely have to put in a lot more effort than other people" (*more effort condition*); or "like everyone else, you would likely have to put in a lot of effort (*normal effort condition*)." The male research assistant from the other room told the main experimenter that the connection to submit the remaining surveys was still working, and then exited the room leaving the participant to complete the dependent measures.

Measures. Participants completed the academic belonging measure used in Study 1 to reflect anticipated belonging with eco-psychology (Walton & Cohen, 2007; sample item: "I would get along well with people in eco-psychology"; $\alpha = .72$) as well as a 4-item measure of how competent they felt they would be in the eco-psychology field (see Smith et al., 2007; sample item: "I feel that I would do eco-psychology well"; $\alpha = .77$). We also assessed feelings of self-doubt (using the 17-item scale by Oleson, Poehlmann, Yost, Lynch, & Arkin, 2000; sample item: "Sometimes I feel that I don't know why I have to succeed at something"; $\alpha = .65$) and a checklist of behaviors to indicate motivation to pursue eco-psychology (e.g., "Please check here if you would like to be added to the MEP mailing list; check here to be mailed more information about the program when it comes to MSU; check here to receive an application to the program at Boulder; check here to be mailed a copy of the brochure for the program"). The percentage of items requested formed the index of future motivation ($\alpha = .70$). Finally, participants completed a demographic survey, were debriefed, and probed for suspicion.

Results and Discussion

Separate one-way ANOVAs were conducted on each of the dependent measures. Results yielded a significant effect of expectation condition on feelings of anticipated academic belonging in eco-psychology, $F(3, 37) = 2.93$, $p < .05$, $R^2 = .19$; perceived competence, $F(3, 37) = 3.18$, $p < .05$, $R^2 = .20$; self-doubt, $F(3, 37) = 3.23$, $p < .05$, $R^2 = .16$; and future motivation for eco-psychology, $F(3, 34) = 3.17$, $p < .05$, $R^2 = .18$. We followed up this interaction with Fisher's Least Significant Difference (LSD) tests (see Table 3), which found that women in the *normal effort* condition showed significantly higher feelings of anticipated academic belonging for pursuing eco-psychology compared with participants in all other conditions (see Table 3 for descriptive data) and greater perceived competence, future motivation, and less self-doubt compared with participants in the *more effort* condition. In addition, the natural ability condition and no information condition were always equally low. This suggests that women who learned about a male-dominated graduate program but were told no other information might have assumed that "natural ability" would be emphasized. Thus, when women are considering a male-dominated graduate program, being explicitly told that success can come about by expending similar amounts of effort as other students brings about elevated feelings of belonging and motivation to pursue the field.

General Discussion

In three studies, we found that women in STEM fields perceive that they must exert greater amounts of effort than others to succeed, and these results are in part due to the male-dominated nature of these fields. Despite having equal ability, women's feelings of belonging with and motivation to pursue STEM fields varied as a function of effort expenditure concerns (Study 1). Viewing a novel field as male-dominated triggered concerns about effort expenditure and also reduced motivation for women but not for men (Study 2). This suggests that women interpret the numerical underrepresentation of women in a field as a cue that they will have

Table 3. Study 3 Descriptive Statistics and Analyses by Condition

	Expectation condition							
	No information		Natural ability		More effort		Normal effort	
	M	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*
Academic belonging (1 to 7 scale)	3.98_{a}	.23	4.12_{a}	.23	4.20_{a}	.23	4.84_{b}	.22
Perceived competence (1 to 7 scale)	5.08_{ab}	.29	$5.09_{a,b}$	.31	4.41_{a}	.31	5.77_{b}	.31
Self-doubt (1 to 6 scale)	3.09_{a}	.23	$2.84_{a,b}$	.23	2.96_{a}	.22	2.25_{b}	.23
Future interest (Percent of items requested)	3.33_{a}	.03	0.00_{a}	.00	7.41_{a}	.05	30.00_{b}	.13

Note: Means not sharing a subscript are statistically significantly different at $p < .05$ as determined using Fisher's Least Significant Difference tests. All participants were women.

to exert more effort than other people to succeed. However, by reassuring women that everyone has to expend a lot of effort appears to make women more optimistic about their prospects in these fields (Study 3).

What is unique about effort comparison concerns is that women's perceptions of fit in a field come from within women themselves, representing a bias in attributions about their own abilities (Sekaquaptewa, 2011). It is concerning that women seem to be either misperceiving their peers' level of effort and/or the meaning of their own level of effort in comparison. However, our results are also encouraging in that they suggest possible interventions that may be relatively easy to implement. Results of Study 3 show that making it clear to women that effort expenditure is typical and expected appears to override the default assumptions that success in a science field requires "natural" scientific ability (which women are stereotyped to lack). We found that normalizing effort—stressing that everyone has to work hard to achieve success—resulted in higher self-reported feelings of belonging and future interest in the field. As suggested by the Carol Dweck quote opening this article, similar positive effects may emerge when STEM practitioners talk openly to one another (and to their students) about the struggles and effort it takes to succeed in STEM fields.

Extant research examining women's asymmetrical participation in STEM has centered primarily on what factors affect women's actual performance on domain-relevant skills (e.g., math performance) at the undergraduate level. In line with the current project, this past work has shown that emphasizing effort (as opposed to innate talent) can lead to better objective performance outcomes (e.g., Aronson, Fried, & Good, 2002). Such natural ability/effort distinctions are important, because STEM fields are stereotyped as a domain requiring natural ability to succeed and thus putting forth effort is viewed as a symbol of inability (Tsay & Banaji, 2011). For example, exposure to information that differences in math ability are a result of stereotypes (vs. natural talent) positively influences women's math performance; but when told nothing at all, women assume that gender differences in math ability are a result of (a lack of) natural abilities (e.g., Dar-Nimrod & Heine, 2006; see also Thoman, White, Yamawaki, & Koishi, 2008). Likewise, when girls learn that a "growth" incremental theory of intelligence is part of what makes a good mathematician, the negative performance effects of stereotype threat can be offset (e.g., AAUW, 2010; Aronson et al., 2002; Good et al., 2012).

Given that perceptions of performance and domain-related motivation are frequently stronger predictors of retention and academic success than actual performance (Ehrlinger & Dunning, 2003; Renninger, Sansone, & Smith, 2004), our findings about subjective self-perceptions and motivational outcomes make an important contribution (see also Stout et al., 2011). The next step for research would be to examine a more complex motivational process as a function of effort expenditure comparison concerns. How much effort a woman believes she must exert to succeed compared with other people may impact whether and how a woman in STEM regulates her motivation, which in turn might affect her experience of interest in the field (see for example, Smith, Wagaman, & Handley, 2009).

The current work is not without limitations. We sampled participants only from within STEM disciplines in Study 1 and used a fictional STEM domain in Studies 2 and 3. Thus, one lingering question is whether the patterns we have identified here are unique to women in science and math fields or if they would generalize to women in other domains (e.g., the humanities) as well, and whether and how men would be influenced by an intervention such as the one used in Study 3. However, given the complex interplay of factors unique to STEM fields, including underrepresentation of women faculty and students (National Science Foundation, 2011) and stereotypes that suggest that women are less talented than men at STEM-related abilities (Holleran et al., 2011; Steele, 1997), we believe that STEM fields are a different beast than other disciplines. We speculate that men would likely be unaffected by the "common struggle" intervention (see also Walton & Cohen, 2011) given that their perceptions of relative effort expenditure are unrelated to belonging or domain motivation; however, a conclusive answer will require future research.

Another limitation of this work is that we did not follow our participants longitudinally so we could not directly

assess attrition from STEM fields, only variables known to be related to attrition. We suspect that the negative effects of feeling as though one has to exert more effort than others contribute to women's asymmetric attrition from STEM. However, future research that explicitly tests this by following women through the STEM "pipeline" is needed.

Our results have important implications for why academically capable women leave graduate level programs in STEM (Study 1) or are not interested in graduate level programs in STEM (Studies 2 and 3) and suggest that members of the scientific community would do well to change the culture of science to one that celebrates how much hard work goes into good science. Such an emphasis may encourage women to pursue and persist in STEM. The overall goal of attracting more women to STEM fields should not be to force women to change and assimilate to the (masculine) science culture, but rather to create a STEM culture that is inclusive and allows diverse approaches to flourish.

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Notes

1. Although some of these items reference belonging with the larger university community as opposed to a specific department or program, we expected graduate students' experience with their university to be synonymous with their experience with their specific department. So we opted to use the full set of items to assess academic belonging.
2. The outcomes of all significance tests in the hypothesized model remain the same after controlling for self-reported GPA.
3. The previously used comparative measure was significantly correlated with the difference in self- and peer ratings ($r = .52$, $p < .001$) suggesting that these variables are assessing similar constructs. As further support that our results hold regardless of whom women compared themselves with, we examined the mediation analyses detailed above using the comparative items separately for women who later brought to mind a male versus female peer as a comparison target in the absolute ratings. The pattern of results remained the same regardless of the gender of the comparison target.

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