The Role of Self Doubt and Empathic Accuracy in STEM Fields

Kristina Lowney
Psychology

Sara Hodges
Psychology, Associate Dean of the Graduate School

Adrienne Wise
Psychology

Colton B. Christian
Psychology

Funds from the University of Oregon's Center or the Study of Woman in Society and the office of the Vice President for Research and Innovation supported the larger project from which the data in this paper were drawn.

Women have historically been underrepresented in STEM (science, technology, engineering, and math) domains, although their performance has been on a par with that of their male peers (Smith, Lewis, Hawthorne, & Hodges, 2012). One of the main issues in STEM has been retaining women. The analogy of the "leaky pipeline" describes the way in which women in STEM are lost along the way (Alper, 1993; Smith et al., 2012) as they progress through their careers. Research by Drury, Siy and Cheryan (2011) asserts that by using a more egalitarian approach in recruitment of potential STEM students, the chances of recruiting and retaining women might be more successful in these fields. Additionally, women

observant to the gender imbalance found in STEM fields might reflect self-doubt about their ability to be successful in the future within STEM domains (Lewis & Hodges, 2014). There is a need to examine the reasons why women are slowly dropping out of science fields because this trend restricts diversity and limits possible contributions to the future of science.

When making the decision to advance in academic or career fields, people often rely on feedback to gauge their current and future performance. The way a person interprets that feedback, constructive or otherwise, may be a determining factor in one's motivation to continue to pursue an academic or career goal. In order to accurately interpret feedback from others, people need to have a skill called empathic accuracy, which refers to how well people can "read" others' thoughts and feelings (Hodges, Lewis, & Ickes, 2015). In most situations, being able to correctly infer the thoughts of others may be helpful. However, if feedback is perceived negatively, even if perceptions are accurate, it may do more harm than good in terms of motivating persistence.

Previous research has shown that women are often more empathically accurate than men. On the other hand, some studies have revealed no significant gender difference in empathic accuracy. However, although men have performed similarly to women in some studies, they do not perform better than women (Hodges, Laurent, & Lewis, 2011). The implications of heightened empathic accuracy in women, in addition to preconceived ideas of female competence in specific domains, could result in women reading feedback more negatively in fields where they are underrepresented. This might be one reason that women are hesitant to continue to pursue certain male dominated fields such as STEM.

Based on previous studies of empathic accuracy, we predicted women would be more empathically accurate overall in perceiving the feedback they receive in STEM fields in comparison to men. An additional hypothe-

sis focused on the idea that because women are underrepresented in STEM fields, they would report higher levels of self doubt in those fields. Furthermore, because students who score higher in self doubt may be more attentive to feedback if they are unsure of their belonging and ability in the STEM fields, we expected to see that individuals with high self-doubt scores, regardless of gender, would be more empathically accurate in perceiving feedback about their STEM abilities.

Empathic accuracy refers to the extent in which people are correct when inferring the thoughts and feelings of others. On a daily basis, we participate in the process of inferring others' thoughts, and the content of those inferences in turn affects our behaviors and thoughts about ourselves and others. Research suggests that being able to read the thoughts and feelings of others may be beneficial in creating and maintaining social relationships (Hodges et al., 2015). As mentioned above, women are often but not always more empathically accurate than men (Hodges et al., 2011). Traditional gender roles have placed women in positions that encourage reading others and communicating effectively to help build and maintain relationships. This may be one reason women are more skilled at reading the thoughts and feelings of others (Hodges et al., 2011).

Encoding cues in male-dominated environments such as STEM fields could heighten women's vulnerability to perceiving negative feedback, which in turn may impact their feelings of competency. When women interpret feedback as being negative, they show a decreased motivation to put effort into performance (Biernat & Danaher, 2012). In addition, female students hold lower expectations of themselves relative to their male peers, which often results in a decreased effort to overcome academic obstacles (Tan & Pang, 2012). However, women witnessing other successful females in STEM may exhibit increased confidence in their ability to pursue those fields (Stout, Dasgupta, Hunsinger, & McManus, 2011). A study

by Cheryan, Siy, Vichayapai, Drury, and Kim (2011) revealed that women who encountered female role models in STEM fields reported more belief in their future success within those fields. These studies together would suggest that women might be highly perceptive to certain cues encountered in their introductory experiences within STEM fields.

People are motivated to establish a sense of belonging. This innate drive aids us in creating and maintaining social support (Baumeister & Leary, 1995). Belonging is especially important in certain areas, such as academics, where it predicts performance and perseverance (Lewis & Hodges, 2014). According to Lewis and Hodges, a lack of academic belonging may predict feelings of self doubt and uncertainty. A strong sense of belonging, particularly in academia, informs students that they are deserving of the same opportunities as others. When one perceives a sense of inequality relative to one's peers, it can often result in decreased motivation and intentions to persist (Lewis & Hodges, 2014). Women may derive feelings of self doubt from a decreased sense of belonging and therefore may question their place and competence in STEM fields.

Method

Participants:

Undergraduate and graduate students were recruited from STEM fields through email solicitations using various resources on campus (e.g., dean's lists and departmental faculty contacts). Participants were students at the University of Oregon and Oregon State University. Undergraduate participants (72 total; 38 males and 34 females) had an interest in attending graduate school in a STEM field. Also participating in the study were graduate students, both males and females pursuing PhD degrees in the science fields. They were asked to give feedback to the undergraduates. The science fields from which both undergraduate and graduate students

were drawn were physics, computer and information science, biology, chemistry, biochemistry, geology, and engineering.

Procedure:

Dyads consisting of one graduate student and one undergraduate student in the same STEM field were scheduled to hold a 10-minute video recorded conversation about graduate school. The undergraduate students were asked to discuss why they wanted to go to graduate school as well as why they would be qualified candidates. In addition, they were asked to report anything they had done to prepare for a graduate program. The graduate students were instructed to answer questions and give advice to the undergraduate students regarding graduate school. The dyad's conversation was recorded with only the graduate student visible on video.

The undergraduate and graduate students were separated into different rooms to watch the video of the conversation they just had. Graduate students viewed the recording of the interaction while a research assistant stopped the video every 45 seconds. The graduate students were instructed to note the content of their specific thoughts during the original conversation at each 45-second video pause. The undergraduate students also viewed their respective videos, and a research assistant stopped the video every 45 seconds at the same time points it was originally stopped for the graduate students. The undergraduates were asked to guess the thoughts of the graduate students during the original conversation at each 45 second video pause.

Each graduate's thoughts and undergraduate's inferences were later coded for empathic accuracy. Four coders read each reported graduate student thought and rated how closely the undergraduate's inference matched the thought, using a 4-point scale with "0" given to inferences that failed to capture any aspect of the thought and "3" assigned to inferences that

captured the gist of the thought entirely.

During the study, both members of each student dyad were asked about their perceptions of the qualifications of the undergraduate in terms of a future in graduate school. The undergraduate students reported how they thought the graduate student perceived their prospects and how their own prospects compared to other applicants. In addition, undergraduates answered a series of questions using Likert scales (from "very unlikely" to "very likely") to indicate their future aspirations of going to graduate school (Smith et al., 2013). Finally, the undergraduate students answered questions scoring their feelings of self-doubt, using Oleson and colleagues' (2000) self doubt scale. The scale uses a 6-point Likert scale (e.g. "strongly disagree" to "strongly agree") with eight questions inquiring about participants' general confidence in tasks and abilities.

Results

In the current study, we hypothesized that women would be overall more empathically accurate than men when interpreting feedback in the STEM domains. Empathic accuracy was coded by four different people. Inter-rater reliability was assessed using Cronbach's alpha, which was found to be 0.90, a high level of inter-rater reliability. We averaged scores from all four of the coders to compute an empathic accuracy score for each inference. A mean empathic accuracy score was then computed for each undergraduate student by averaging across inferences. An independent t-test revealed no significant difference in mean empathic accuracy scores for females ($M = 0.83$, $SD = 0.31$) and for males ($M = 0.81$, $SD = 0.36$), $t(70) = -0.23$, $p = .82$.

Additionally, we had predicted that women would score higher on self doubt compared to men. We computed self doubt scores by averaging across all self doubt items. A t-test revealed that there was also no differ-

ence between mean self doubt scores for females (M = 3.30, SD = 0.77) and for males (M = 3.17, SD = 0.84), $t(70)$=-.67, p = 0.51.

Finally, we had hypothesized that regardless of gender, individuals who reported higher self doubt would be more empathically accurate. A bivariate Pearson's correlation did not reflect a significant relationship between empathic accuracy and self doubt scores, r(70) = .09, p = .45.

Discussion

Previous research in empathic accuracy has suggested that women are often more empathically accurate than men. However, in this study, interestingly, we did not find a significant difference in the empathic accuracy scores when comparing men and women. Although some past studies have found no difference when comparing men and women's empathic accuracy, we thought we might see an advantage for women in terms of empathic accuracy in STEM fields, where we expected women might be hyper vigilant when reading feedback. Additionally, we found that there was no significant difference in reported self doubt when comparing genders. Therefore, although women are underrepresented in the STEM fields, in our sample, it was not necessarily reflected in undergraduate students' confidence in their abilities. Furthermore, we found that people who score higher in self doubt were not necessarily more empathically accurate when reading feedback in the STEM fields.

This study has some limitations. For example, we treated all STEM fields the same; however the underrepresentation of women varies somewhat from field to field, and some of the domains we studied may not have had that much gender imbalance. For example, biology is one of the domains that is more equally gender-balanced. Future research may benefit from focusing on domains within STEM that reflect a greater gender imbalance, such as physics and chemistry.

Moreover, because participants volunteered to be in the study, there may have been a bias in those who chose to participate. In particular, female graduate students and male graduate students who were excited about encouraging undergraduates in STEM may have been overrepresented. Undergraduate students, women in particular, may encounter less supportive STEM graduate students in the course of majoring in STEM than they did in this study. Additionally, although it is an established methodology for measuring empathic accuracy (Hodges et al., 2015), the measure of empathic accuracy used in this study was retrospective in nature, and therefore the thoughts the graduate student participants were reporting may not have been precisely what they were thinking at the particular moment they said they were thinking it.

Although self-doubt was not a strong predictor of how women accurately interpreted feedback in STEM fields for this study, it is important to consider that it might still play a part along with other factors that contribute to the loss of women in the STEM pipeline. This study was focused on undergraduate students, which is not necessarily where women are leaking out of the pipeline. Instead greater "leakage" trends are observed more often in graduate schools, post doctoral programs, and STEM careers. Additionally, it is possible that the female undergraduates who participated in our study were already fairly confident in their abilities and highly identified with STEM as they demonstrated the intention to attend grad school in their fields by voluntarily participating in the study. If these female undergraduates were highly identified with STEM, it might have helped to counteract self-doubt.

In closing, people pick up cues in their environment that help them determine a sense of belonging. The more sensitive one is to these factors, the more vulnerable one might be to doubting one's ability to succeed in certain academic areas (Lewis & Hodges, 2014). We thought that women

might be especially prone to self doubt in the STEM fields, where they continue to be underrepresented. By gaining a deeper understanding of the factors that deter women from persisting in STEM domains, we might be able to find a way to increase recruitment and retention in the STEM fields.

References

Alper, J. (1993). The pipeline is leaking women all the way along. *Science, 260*, 409-411. doi: 10.1126/science.260.5106.409

Baumeister, R. F., & Leary, M. R. (1995). The need to belong: Desire for interpersonal attachments as a fundamental human motivation. *Psychological Bulletin, 117*, 497–529. doi:10.1037/0033-2909.117.3.497

Biernat, M., & Danaher, K. (2012). Interpreting and reacting to feedback in stereotype-relevant performance domains. *Journal of Experimental Social Psychology, 48*, 271–276. doi:10.1016/j.jesp.2011.08.010

Cheryan, S., Siy, J. O., Vichayapai, M., Drury, B. J., & Kim, S. (2011). Do female and male role models who embody STEM stereotypes hinder women's anticipated success in STEM? *Social Psychological and Personality Science, 2*, 656–664. doi:10.1177/1948550611405218

Drury, B. J., Siy, J. O., & Cheryan, S. (2011). When do female role models benefit women? The importance of differentiating recruitment from retention in STEM. *Psychological Inquiry, 22*, 265–269. doi:10.1080/104784 0X.2011.620935

Hodges, S. D., Laurent, S. M., & Lewis, K. L. (2011). Specially motivated, feminine, or just female: Do women have an empathic accuracy advantage? In J.L. Smith, W. Ickes, J. Hall, & S. D. Hodges (Eds.), *Managing interpersonal sensitivity: Knowing when -- and when not -- to understand others* (pp. 59-73). New York: Nova Science Publishers.

Hodges, S. D., Lewis, K. L., & Ickes, W. (2015). The matter of other minds: Empathic accuracy and the factors that influence it. In P. Shaver, M. Mikulincer (Eds.), J. A. Simpson, & J. Dovidio (Assoc. Eds.), *APA handbook of personality and social psychology: Vol 2. Interpersonal relations and group processes* (pp. 319-348). Washington, DC: American Psychological Association.

Lewis, K. L., & Hodges, S. D. (2014). Expanding the concept of belonging in academic domains : Development and validation of the Ability Uncertainty Scale. *Learning and Individual Differences, 37*, 197–202. doi:10.1016/j. lindif.2014.12.002

Oleson, K. C., Poehlmann, K. M., Yost, J. H., Lynch, M. E., & Arkin, R. M. (2000). Subjective overachievement: Individual differences in self-doubt

and concern with performance. *Journal of Personality*, *68*, 491–524.

Smith, J. L., Lewis, K. L., Hawthorne, L., & Hodges, S. D. (2012). When trying hard isn't natural: Women's belonging with and motivation for male-dominated STEM fields As a Function of Effort Expenditure Concerns. *Personality and Social Psychology Bulletin*, *39*, 131–143. doi:10.1177/0146167212468332

Stout, J. G., Dasgupta, N., Hunsinger, M., & McManus, M. a. (2011). STEMing the tide: Using ingroup experts to inoculate women's self-concept in science, technology, engineering, and mathematics (STEM). *Journal of Personality and Social Psychology*, *100*, 255–270. doi:10.1037/a0021385

Tan, S. H., & Pang, J. S. (2012). Sticks and stones will break my bones but failure feedback may not hurt me: gender differences in the relationship between achievement motive, coping strategies and environmental mastery. *Educational Psychology*, *32*, 373–388. doi:10.1080/01443410.2012.662148