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UNDERSTANDING SUBTLE GENDER BIAS RECOGNITION AMONG WITNESSES IN A STEM UNDERGRADUATE CONTEXT

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UNDERSTANDING SUBTLE GENDER BIAS RECOGNITION AMONG WITNESSES IN A STEM UNDERGRADUATE CONTEXT

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Dedications

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Author Contribution Statement

The study in chapter 2 is based on research conducted in conjunction with a multi-study National Science Foundation (NSF) grant project. Some of the results of this study were submitted as a paper and poster in 2022 to the American Society of Engineering Education (ASEE). The submission was co-authored by Darnishia Slade (now Darnishia Morris), Logan Burley, Denise Sekaquaptewa and Lorelle Meadows. Darnishia was the corresponding author of the manuscript and primary presenter of the results during a poster session. It has been adapted for the purposes of this dissertation with permission of the co-authors and the chapter provides additional analyses not described in the paper. The initial data analyses were conducted at the University of Michigan. Darnishia's contributions to this study included study design support, determining majors that were recruited and identifying recruitment strategies, discussion, evaluating and interpreting results.

The study in chapter 3 is based on research conducted in conjunction with a multi-study NSF grant project. This is the second study of five. Darnishia Morris was the lead researcher on this project, including study design, recruitment, communication with participants, and scheduling/facilitating study sessions. She collaborated with colleagues at the University of Michigan on the data analyses and she completed the reporting of findings.

For the study in chapter 4, Darnishia Morris designed the study and was solely involved in the research design, recruitment of participants, execution of the study, analysis, and reporting of findings and all other aspects of this study.

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Abstract

This dissertation builds on knowledge of how witnesses recognize subtle gender bias (often referred to as gendered microaggressions) in a STEM undergraduate context. This body of work provides a better understanding of the implications of observing these events of subtle bias and the role that recognition plays in providing opportunities to adopt stereotype defying behaviors. The impressions and influences on both witnesses who belong to the marginalized group (target witnesses) and those in majority groups (non-target witnesses) were examined. Three interrelated studies explored how recognition might disrupt the cyclic impact of subtle gender bias when participants witness collaborative STEM team interactions via video. Study 1 was a quantitative study, assessing the influence of witnessing subtle gender bias on stereotype endorsement, revealing that witnessing subtle gender bias can increase explicit endorsement of gender stereotypic beliefs for both men and women. However, those who recognize bias report lower explicit endorsement of STEM stereotypes, at a level comparable to not witnessing bias. Thus, recognition of bias may serve the role of breaking a recursive process that allows the propagation of STEM gender stereotypes. Study 2 assessed these same effects on performance and persistence, finding that when women detected gender bias in the environment, they were less enthused about engagement with the team they observed, even though their performance on a spatial ability test was not negatively impacted. Because recognition can change how people endorse stereotypes and how they feel about joining an environment, Study 3 focused on how individuals recognize bias. This qualitative study targeted a majority population (cis-gendered white men). The aim was to understand the cues, feelings, and mental models they used while observing and making sense of subtle gender bias events as

they witnessed STEM team interactions. The three studies provide novel contributions to understanding the majority population's key mental models related to subtle gender bias detection, and emphasized the role of mainstream language, empathy, and emotional intelligence on the recognition of subtle gender bias.

Keywords: microaggressions, subtle gender bias, bias recognition, STEM education

Gendered microaggressions (MA) are subtle biases that commonly occur in the everyday lives of women. MA manifest because of a present, but not consciously held, prejudice toward an individual, a thing, or a group. These behaviors have the potential to cause harm or emotional damage to those who are impacted. MA are not blatant, overt, nor intentional, but they can have detrimental effects on the targets by causing them to feel unwelcome, unheard, or devalued. These detriments can potentially lead to long-term negative consequences such as doubting the validity of their experiences/emotions and an impairment of an autonomous sense of one's own identity (Freeman & Stewart, 2021). Mulvey and Irvin (2018) found that gender stereotyping emerges early in a girl's life. Women in STEM experience stereotypes such as consistently being assigned secretarial or writing tasks or being told that men are superior on STEM-related tasks (McKinnon & O'Connell, 2020). The influence of societal cues has dictated to women that certain career choices are primarily for men. Research has shown that there is a tendency for girls to think of themselves as being smart at an early age (Bian et al., 2018). But when women experience MA, they can exhibit reduced self-belief, gender isolation, and stereotype threat (True-Funk et al., 2021). Jones and colleagues (2016) argue that these types of biases are more detrimental than overt biases. In academia, there is a general lack of support for and solutions to the subtle biases women experience daily.

The negative effects of repetitive bias experiences can result in women studying STEM to have mental health issues, lack a sense of belonging, and experience compromising social interactions (Smith & Silva, 2011). When observers don't recognize these subtle slights, stereotype supporting behavior occurs and these behaviors are perpetuated, replicated, and reinforced in the environment (Pierce, 1974). Consequently,

women in STEM experience academic/career burnout resulting in an inclination to leave STEM fields altogether (Fouad et al., 2012). In both academia and in the workforce these factors impact the ability for women to achieve and perform (Frehill, 2004). This phenomenon is generally referred to as the “leaky pipeline.”

One way to mitigate the toxic effects of pervasive subtle bias may be related to recognition that the events occur. Thus, the aim of this dissertation is to gain a greater understanding of subtle gender bias recognition, its impact, and the types that are easier or more difficult for witnesses to detect. For instance, a 2015 (Carnes et al.) study found that when faculty at the University of Wisconsin-Madison participated in 2.5-hour gender-bias habit-reducing intervention, the faculty expressed greater actions to promote gender equity and self-efficacy beliefs. The intervention aided in an overall improved academic climate and highlighted how important an awareness of one’s own bias can help individuals make behavioral changes. Therefore, attempts to reduce bias in academia can consist of intervention techniques designed to aid in one’s ability to recognize subtle gender biases when they occur and thus assuage the detrimental effect of accumulated subtle biases. Thus, obtaining a greater understanding of how recognition of subtle bias occurs can be used to improve the climate for women in STEM, by breaking the cycle of seeing bias, accepting it, and sustaining it in higher education settings.

The specific focus of this work is to explore how one’s ability to recognize subtle gender biases might provide an opportunity to remediate occurrences of gendered MA on college campuses. The research questions I propose to answer include:

- How does witnessing subtle gender bias events influence stereotype assimilation.

- How does recognition of subtle gender bias events affect STEM student's perceptions of gender stereotypes?
- How does recognition of subtle gender bias events affect STEM student's performance and persistence?
- What types of subtle gender biases do majority group members (e.g., white men who usually aren't the targets of STEM stereotypes) detect when they witness them in a student engineering team context and how are they interpreting what they observe?

Chapter 1 provides a literature review outlining previous research related to gendered MA and subtle gender bias experiences of both targets and majority population individuals who experience and witness biases. Through a series of three studies, I investigate the above-mentioned research questions. Chapter 2 describes Study 1, which involves evaluating the effects of subtle bias exposure and recognition on implicit stereotype activation and explicit stereotype endorsement. Chapter 3 describes Study 2, which involves exploring the effects of witnessing and recognizing subtle bias on performance and persistence. Chapter 4 describes Study 3, a qualitative study involving white men (a majority population) to gain a deeper understanding of the cues and antecedents that lead to an ability to detect subtle bias interactions when they witness them. By identifying the mental models used by majority group members when they witness subtle gender bias, effective interventions can be designed that may help to avoid the reinforcement of stereotypes and subtle bias behaviors in STEM settings, improving the climate and outcomes for everybody. Chapter 5 summarizes the overall conclusions of this body of work and its contributions and next steps to advance the understanding of bias recognition in STEM environments.

Chapter 1 ~ Literature Review

Microaggressions/Subtle Bias

Microaggressions are small verbal and non-verbal insults and snubs that are not deliberate, but communicate exclusion, hostility, and degrading messages to marginalized groups of individuals (Sue et al., 2007). They reflect one's attitudes, beliefs, and social norms within a system. This system can be society, academia, workplace, a cultural group, etc. For individuals who are targets of MA, these pervasive slights communicate hostile, derogatory, or negative messages that target persons based solely upon their membership in a marginalized group such as race, gender, weight, or disability among others (Sue et al., 2007).

Dr. Chester Pierce (1974) introduced MA to articulate the effects of racism specifically in relation to Blacks in America. Pierce informed us that MA led to the statistical early demise of Blacks and to their incomparably higher morbidity and mortality rates. In their research efforts, Sue and his peers (2010) emphasize that MA are often delivered by well-intentioned individuals who are not aware that they are devaluing a marginalized group. Thus, MA may be perceived as harmless or trivial, but their widespread effects can result in (a) a hostile campus climate; (b) devalued social group identities; (c) lower work productivity and educational learning; (d) perpetuating stereotype threat; (e) physical health problems; and (f) mental health challenges created by emotional turmoil, low self-esteem, and psychological energy depletion (Sue, 2010).

One of the major determinants of MA is their cumulative nature. The effects of MA in our society can be alarming and persistent. Recently, the term MA has come under scrutiny; more specifically the prefix "micro." Tulshyan (2022) argues that "micro" has the tendency to minimize the effect of these behaviors and does not adequately

reflect the impact on the individual being marginalized. Thus, subtle bias is a present-day term used to further clarify the hidden nature of MA and its lasting impact. Previous studies have demonstrated that these subtle experiences can be more damaging than overt events of bias (Jones et al., 2016). Subtle biases can be conscious or unconscious, they can be the unintentional thoughts, impressions, and beliefs that one holds about a person or group. These biases, while discrete in nature, have a weighty effect on behaviors, interactions, and the way people make associations with others.

Women who pursue STEM majors face subtle bias in these historically male-dominated fields. When a critical mass of women isn't present in classrooms/project groups, there is a strong likelihood of permeating subtle gender biases in student-student interactions (Ingram & Parker, 2002). For example, in working groups where women are ten percent or less, women received lower performance ratings than men; however, when women represent more than fifty percent, they have more positive performance ratings compared to men (Sackett et al., 1991). In addition, when a critical mass (at least one third of the classroom/team population) is present, individuals are less stereotyped, and everyone is viewed as more individualistic (Valian, 1998). In situations where women are under-represented, there is also a tendency for women to take on stereotypical tasks and responsibilities such as writing the minutes or monitoring the time during a team/lab meeting (Meadows & Sekaquaptewa, 2013).

Table 1 is a summary of four pathways of microaggressive stress identified by Sue (2010). When individuals are impacted by these interactions, concerns such as frustration, occupational stress, difficulty focusing, anger, depression, disrupted sleep, fatigue, heart disease can arise (Torino, 2017). Furthermore, when these bias-related

stressors are left unsupported or invalidated they can become seriously detrimental to the target.

Table 1

Four Pathways of Microaggressive Stress

Biological and Physical Effects	Emotional Effects	Cognitive Effects	Behavioral Effects
Accumulation of chronic stress equal to the effect of a major catastrophic trauma. As well as issues related to blood pressure and immune health.	Anxiety, feelings of alienation, subjective well-being, and exhaustion.	Subconscious energy is expended in an attempt to make sense of situations.	A hostile or invalidating environment, assails self-esteem, and imposes forced compliance (oppression) upon targets.
Example: Gendered racial microaggressions were associated with worse sleep health in black women. (Erving et al., 2023)	Example: Gender biases in STEM have resulted in a decrease in sense of belonging and caused women graduate students to question their continued enrollment. (Wilkins-Yel et al., 2019)	Example: Stereotype threat has been found to lead self-efficacy decreases in professional women in STEM. (Cadinu et al., 2005)	Example: When women see other women in STEM environments being devalued stereotype activation can produce the perception that men's performance and contributions and more valuable than women's. (LaCosse et al., 2016)

Biological and Physical Effects

Simard and colleagues (2008) showed that women who are mid-level scientists or engineers were in worse health than their men counterparts due to factors such as work demands, work environment, long hours, the responsibilities of motherhood, home and family. The culminating health factors related to bias experienced in the work force can create a permeating adverse climate for women who pursue these historically male-dominated studies in STEM (Hill et al., 2010). Researchers who study the subtle biases

of women in STEM describe these fields as chilly (Hall & Sandler, 1982) and depressive (Cortina et al., 1998). Also, individuals identify as woman scientist tend to perform lower in their academic courses while also experiencing mental health challenges such as depression and overall life dis-satisfaction (Settles, 2004).

Emotional Effects

Microaggressions have the tendency to accumulate and leave women in STEM disengaged, disempowered, and isolated on college campuses (Steele et al., 2002). Since subtle bias detection is difficult, there is little recourse resulting in limited resources for those who experience them on a daily basis. For example, Tao and colleagues (2017) found that individuals expressed more negative emotions after witnessing bias, compared to when the interaction was a positive experience. There is often an ongoing feeling of being regarded as a second-class citizen and inferior (Nadal et al., 2014). Researchers have found that those experiencing subtle biases are challenged with a rollercoaster of emotions. For instance, when facing the decision of whether to respond to a slight, there is an internal conflict of questioning the associated emotional consequences of responding (Jones, 2022).

Cognitive Effects

Women in STEM can be challenged by self-efficacy issues such as imposter syndrome or a lack of a voice in the classroom and within their respective academic departments (Ayre et al., 2013). Stereotype threat can manifest as one of the cognitive outcomes. Stereotype threat happens when there is the opportunity or perceived opportunity for women to reinforce or validate the traditionally held stereotype that women in STEM are less capable and competent (Steele & Aronson, 1995). Factors related to stereotype threat result in a decrease in academic focus and performance

(Settles et al., 2016) for women in STEM majors. Previous research also shows that women also experience social isolation because they are seen as outsiders by men in the organization, creating an added pressure to prove themselves and perform academically (Ingram & Parker, 2002). As subtle biases are happening, an individual's cognitive resources can be consumed with determining whether these subtle slights are discriminatory or not (Holoien & Shelton, 2012). In terms of focus, women who are exposed to MA can become more vigilant as they look for subtle biases and discrimination in their interactions and engagement with others in the environment (Inzlicht et al., 2006), which can cognitively disrupt their ability to focus on the tasks at hand as well as hinder their performance (Ozier et al., 2019).

Behavioral Effects

After thirty years as an engineer, professional women are half as likely to still remain in the profession (Corbett and Hill, 2015). This low retention of women in STEM jobs in comparison to other professions speaks to the high number of women leaving STEM fields for alternative careers; especially within the 12-30 years after entering the workforce. As a result of the progressive decline of women represented in each successive level of the STEM workforce pipeline, women in STEM often find themselves in situations requiring them to (a) to repetitively prove themselves; and (b) to take a masculine approach to be seen as competent (Williams, 2015). This decline is often called the leaky STEM Pipeline which spans from middle school girls to colleges graduates who major in STEM (Buckles, 2019). Furthermore, women who are impacted by gender discrimination often do not feel a strong connection and allegiance to the employer which consequently results in job turnover (Jaffe, 2017). There is also a tendency for women to take-on stereotypical tasks and responsibilities such as

secretarial and organizational roles rather than technical roles (Meadows & Sekaquaptewa, 2013). Subtle behaviors from faculty, staff and peers who reinforce gender stereotype endorsements such as less competency and lowered performance expectations can result in alienation, diminished self-esteem and a lack of sense of belonging when compared to their majority peers (Hurtado et al., 2008). Additionally, over time women can display counterproductive work behaviors (tardiness, sabotage, incivility, and bullying) as a result of perceived gender discrimination in the work environment (Frehill, 2004).

Unless I am referring to specific research findings, throughout the remainder of this dissertation I will refer to the term “subtle bias” as slights that are largely unintentional, have a negative impact as they silently accumulate and eventually combust.

Witnessing Gender Bias

Much of the research discussed above focuses on the direct outcomes of individuals who are targeted by gender bias in STEM. Since these acts can be both persistent and pervasive, it is likely that most individuals in a STEM environment are exposed as witnesses to these behaviors. A 2016 study (Sekaquaptewa et al.), explored the impact of both witnessing and being a target of macroaggressions. 297 students participated in the study, 41% were female and the sample was predominantly white. Participants were asked to identify the frequency with which they had previously experienced gendered MA both as targets and witnesses. The researchers found that women reported more MA than men and participants reported witnessing MA happening to other people more than to themselves. Among STEM participants, women again reported more events of MA and both men and women reported MA happening to other

people (women) more than to themselves. In addition, for women it was found that higher exposure to MA leads to a lower sense of belonging in STEM and higher stereotype threat concerns. Thus, witnessing MA can also be detrimental for women in STEM. Although being a target of MA can certainly be a negative experience, witnessing MA happening in one's environment can also have adverse effects (Kim & Meister, 2022). In addition, the cues hypothesis asserts that stereotype-consistent cues in STEM settings (such as a lack of female representation) can trigger negative outcomes, because stereotypes are activated and become relevant in the situation (Murphy et al., 2007). Cheryan and colleagues (2009) examined the role of physical object cues and found that the mere presence of masculine objects (i.e. Star Trek posters versus nature posters), video games, in a computer science setting deterred women from computer science majors and careers, consistent with work showing the negative effect of stereotypes on motivation, and sense of belonging (Murphy et al., 2007; Johns et al., 2005).

Target Witnesses

Whether the targeted person experiences or observes biased behavior, there is a lasting effect. The associated stress of analyzing and mentally rehearsing or playing-back MA incidents can have a similar impact on cognitive functioning as an individual who is a direct target (Ozier et al., 2019). These stress-related observations adversely impact one's overall well-being and one's ability to have healthy social interactions (Harrell, 2000). Research by Tajfel and Turner (1896) suggests that targeted individuals are likely to have overlapping connections with their experiences and their observations of bias. Repetitive observations of bias against one's group has been shown to create a hypersensitivity to the pervasiveness of discriminatory behavior in both subtle and overt

interactions (Carter & Murphy, 2017). Social identity threat is another implication for women who experience gendered subtle bias. When a target's identity as a woman is threatened by social cues, such as sexist advertisements, behaviors, or interactions, their performance on exams can be negatively impacted (Davies et al., 2002). The biased behavior signals to the women a devaluation of their ability to perform academically (Steele et al., 2002). For example, women who observe unfavorable treatment of their fellow female peers in STEM can experience diminished performance in an academic setting (LaCosse et al., 2016). For women in STEM, sample cues could include seeing objects/images in the environment that reinforce the masculine nature of their major (Cheryan et al., 2009), or witnessing the adverse treatment of other women peers by men during STEM project work (LaCosse et al., 2016). When exposed to these types of environmental cues and peer-to-peer interactions there is a direct connection to negative outcomes such as a decrease in the performance expectations of women (Sekaquaptewa & Thompson, 2003), as well as diminished mathematics and spatial ability test scores (Van Loo & Rydell, 2014; Sanchez-Segura et al., 2018).

Non-Target Witnesses

Non-target witnesses also experience significant negative outcomes related to observing subtle bias. For example, men who read vignettes portraying biased supervisor behavior reported that more negative performance outcomes for all workers will happen as the explicit behaviors persists (Basford et al., 2014). To some extent, majority populations may also experience the fear of being judged by others or deemed sexist when in an environment where gender biases are present (Hyde et al., 1990). In their study, Pietri and colleagues (2019) exposed men and women to video-taped interactions between STEM faculty who demonstrated gender bias toward men and

women graduate students and faculty new to the campus. They found that both men and women who witnessed the bias behavior demonstrated a decrease in trust and sense of belonging. Additional research found that when men and women witnessed gender-directed MA in a work environment they saw more job turnover and diminished overall well-being for those in the workforce (Miner-Rubino & Cortina, 2004, 2007). These studies suggest that all who witness gender MA may experience adverse outcomes.

With these well-known and wide-ranging negative outcomes related to the experience of MA, it is important to consider how to reduce their prevalence. In this work I will explore how recognition of these events by witnesses not only moderates several of these outcomes, but also provides an opportunity for remediation.

Recognition ~ The Ability to Detect Subtle Bias

Biases are narratives and mental models constructed about individuals even prior to knowing them and everyone has them (Myers, 2014). Howard Ross (2020) suggests that if you are human, you are biased. Ross further explains that bias is part of our make-up as humans, one of our survival mechanisms, and overwhelmingly unconscious. Thus, there is a fundamental notion that awareness of one's biases aids us in understanding the powerful nature of biases. Awareness also helps in our ability to detect bias in ourselves and others (Perry et al., 2015). Cech et al. (2016) found that cultural schemas of inequality (how people process information and events in their cultural environment) are contributing factors to bias recognition. In other words, if individuals can detect intolerance when it's at play, they will make efforts (advocacy), or put resources (time and money) toward mitigating their environment or vice versa when they do not recognize intolerant processes. Relevant to this dissertation, the researchers discuss that perceptions of chilly academic and workplace climates are breeding

grounds for inequities to be reproduced. Thus, inquiring about who recognizes marginalization and biases toward women in STEM will aid in articulating processes and may lead to information related to how to interrupt such processes. Research by Lynch et al. (2022) found that when implicit bias instructions are administered during a mock-jury study, participants were more prone to address issues of bias and the importance of a fair and non-defensive discussion related to the problems associated with bias decisions. However, they also found that as a result of administering the instructions, individuals viewed bias as a negative assertion, but not necessarily as a problem to avoid, highlighting that bias consciousness does not necessarily mitigate its harmful effects. In an alternative study, Sabet et al. (2013) found that engaging in cognitive techniques, i.e., disassociation of stereotypic information from marginalized individuals, practicing mindfulness, and attending educational events to reduce their own biases, affords opportunities to advocate for those who are targets of subtle bias.

Jigsaw classrooms is one approach in subtle bias detection. It was introduced in the 1970s as a way to diffuse common social patterns that existed as schools desegregated (Aronson & Patnoe, 1997). This technique leverages a rotating team lead approach, which shifts the classroom atmosphere from competition to cooperation. Rotating the leaders allows for an organized way for groups to learn from one another and take-on the role of an expert. It also aids in acknowledging each students' competency, while creating a systematic way for all voices to be heard and valued. Additionally, as negative stereotyping decreased, students were more self-confident in their contributions to their team, and the overall classroom experience was more enjoyable for all students (Aronson et al., 2002). Thus, research suggests that

maintaining positive social identities while simultaneously introducing cooperative learning strategies aids in bias reduction (Sherif & Sherif, 1965).

An important distinction of subtle bias events is that they often result from different lived experiences between the individuals in the dominant group and those in the marginalized groups and consequently these groups have varying abilities to detect subtle bias when it is happening. The Psychological Adaptation Theory suggests that those who experience frequent occurrences of subtle bias are less affected by those experiences over time (Helson, 1964). From this perspective, prolonged exposure to subtle discrimination builds reduced sensitivity and makes detection difficult over time (Helson, 1964). In other words, they become blind to the events of bias while still suffering the consequences. However, engaging in prejudice reduction strategies such as providing counter-stereotypes (a belief that women excel in STEM) about the targeted individual has been found to serve two purposes. First, it confronts bias when it is present, and second, it generates active/problem-focused coping, which aids the targets to emotionally manage the subtle bias experience (Mossakowski, 2003).

Although witnessing subtle bias events may activate stereotypes, this may not always lead to biased behaviors if people explicitly reject the stereotypes. Research indicates that people can explicitly disown their activated stereotypes. Devine and colleagues (2012) demonstrated that people can become less stereotypically biased when they are aware of what stereotyping is; are motivated to act against it; and practice specific strategies in a sustained effort to avoid stereotyping. Therefore, the negative recursive cycle may be broken if people are motivated to explicitly disown stereotypes and actively strive to be non-biased. The initial factor that may lead people to disown stereotypes activated by witnessing subtle gender bias is their proclivity to recognize

subtle gender bias as stereotyping. Previous research (Johns et al., 2005) suggests that people may be able to temper or even reduce negative outcomes of stereotype activation if they are educated on recognizing subtle bias as being influenced by gender stereotypes. For example, a “teaching intervention” that raised awareness of gender stereotyping and its demonstrated effect on women’s math performance was found to buffer the negative effects of stereotyping of women (Johns et al., 2005). Additionally, reinforced positive images of individuals from marginalized groups helps to dissociate our automatic/innate associations to these individuals, however, this may only temporarily change our automatic assumptions (biases) (Volpert-Esmond et al., 2019).

Literature Review Summary

The novel contribution that this dissertation will contribute to previous research on subtle bias and MA is a greater understanding of the ability to recognize subtle bias interactions and how it plays a role in outcomes related to STEM team interactions and the overall academic experiences of STEM students. In this work I address these concepts by first exploring a conceptual model to determine the impact that witnessing subtle bias events may have on gender stereotype activation. Then I go on to explore the relevancy that witnessing gendered bias interactions has on the performance and persistence of STEM students. Finally, I conclude with obtaining a deeper understanding of the mental models (cues and interpretations) of majority population individuals when they observe subtle bias behavior happening in a collaborative project team setting.

Chapter 2 (Study 1) ~ Recognition of Subtle Bias Tempers Gender Stereotyping Among STEM Students

Consistent with previous research related to witnessing subtle bias (e.g. Murphy et al., 2007), this study explores the assertion that when people witness subtle gender bias events in STEM environments, this can serve as a cue that activates STEM specific gender stereotypes, resulting in stereotype endorsement. In other words, participants will endorse those stereotypes as true or valid, given that the subtle bias event serves to support and maintain the stereotype. For example, when the contributions of women in a technical discussion are ignored in favor of men's contributions, this may serve to activate and validate the stereotypic belief that women are less capable in STEM than men. This can produce a negative recursive cycle: witnessing stereotyping serves to reinforce stereotypic beliefs which then leads to biased behaviors in the observer that are witnessed by others. This cycle can create a negative climate and ultimately contribute to the underrepresentation of women in STEM.

Research Questions

The aim of this study is to address the following research questions:

R1: How does witnessing subtle gender bias events influence stereotype assimilation?

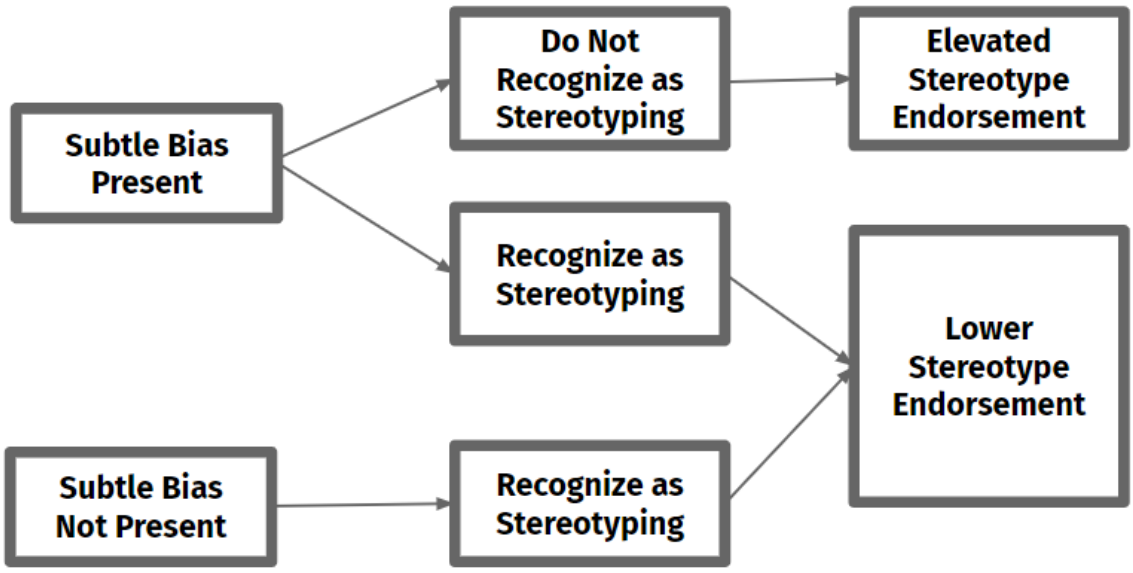
R2: How does recognition of subtle gender bias affect STEM student's perceptions of gender stereotypes?

We hypothesized that an ability to recognize subtle bias as being caused by gender stereotyping may reduce the likelihood of witnesses to endorse stereotypes and increase the likelihood that they will disown stereotypes. People are likely to differ in their tendency or ability to identify subtle gender bias as gender stereotyping. Because subtle gender bias is by its nature ambiguous, it may be interpreted in different ways by

different people. For example, engineering students working on teams may witness a woman team member being assigned to secretarial roles, such as note-taking or report writing, as opposed to more technical roles, following stereotypes of men as engineering experts and women as their supporters. Indeed, research shows that women are disproportionately assigned non-technical roles in engineering student teams (Meadows & Sekaquaptewa, 2013). Some observers may easily identify that the woman is being targeted by these stereotypes. Other observers may see this event as not being related to stereotyping at all, but rather simply the way role assignment played out on the team (e.g., as people “playing to their strengths”). It is proposed that when people do not recognize subtle bias events as stereotyping, they are more likely to engage in greater endorsement of gender stereotypes, seeing as the event they witnessed served to support and maintain those stereotypes. In contrast, people who do recognize the subtle bias event as stereotyping may be more likely to disown stereotypes by engaging in less stereotype endorsement. Figure 1 provides a conceptual model of this process. When people witness and do not recognize and identify bias behavior there is an elevated stereotype endorsement. When people witness, recognize, and identify the bias behavior, there is a lower stereotype endorsement. Finally, when subtle bias is not present, there’s no need to recognize stereotyping.

Figure 1

Conceptual Model Showing Differences in the Response of Individuals to Environments in Which Subtle Bias May Be Present



Note: From "Recognition of Subtle Bias Tempers Explicit Gender Stereotyping Among STEM Students," by Slade et al., 2022, *American Society of Engineering Education.*

Methods

Participants

437 undergraduate student participants from the University of Michigan were recruited via targeted emails. The IRB approved message informed prospective participants that the study was seeking STEM students to participate in a survey on their perceptions and memories of social interactions as well as the people involved. Ten participants were removed for being first year students who had not yet declared a major, fourteen participants were excluded for poor data quality (measured by questions such as, "Did you put forth your best effort in this study?" and, "Is there anything going on in your life or current environment that made it difficult to participate fully, or may

have changed how you normally would have answered?"), five participants were removed for failing to properly complete all measures, and four non-binary participants were removed due to it being impossible to perform meaningful analyses with such a small group of non-binary participants. The final sample included 404 participants: 194 identified as women (48.0%); 210 as men; 197 as White (48.8%); 140 as Asian/Asian American (34.7%); 10 as Middle Eastern/North African (2.5%); 13 as Latinx (3.2%); 10 as Black (2.5%); 4 as Native American (1.0%); 29 as another race (7.2%); and one participant opted not to disclose their race (0.2%). The mean age of the sample was 20.48 years old (SD = 1.61). All participants were enrolled in STEM majors in which women made up 30% or less of the student body (i.e., Aerospace Engineering, Computer Engineering, Computer Science, Electrical Engineering, Mechanical Engineering, Naval Engineering, Nuclear Engineering, and Data Science). Table 2 shows the final number of participants in each condition by gender.

Table 2

Study 1 Participant Breakdown by Condition and Gender

	Men	Women	Total
Control Condition	93	92	185
Bias Condition	117	102	219
Total	210	194	404

Materials

Video Creation and Pre-Test Results

To facilitate the research goals of all three of the studies of this dissertation I leveraged the use of two videos that were created by research colleagues at the University of Michigan. The videos were originally created as part of an NSF grant (DRL-

1420168) focusing on the effects of witnessing subtle bias. The research team created scripts depicting scenes of an engineering student team beginning to work on a project. Four student actors, 2 men and 2 women, were hired to portray the student engineering team in two scripted conditions: one including five events of subtle gender bias, and one with neutral scenes. The scenes were based on previous research and observational data collected as part of the NSF research project to identify common bias experiences of women in engineering. Each script included 11 scenes of which 4 were identical across the conditions (see Table 3). The other 7 were each adapted to portray the bias events or neutral condition.

Table 3

Pretested Video Scene Descriptions

Scene Number	Bias Version	Stereotype Reflected	Control Version
1	A man expresses his surprise that a woman is in a more advanced calculus class than he is.	It is unusual and unexpected for women to be highly competent in STEM.	A woman states she is in an advanced calculus class without comment from others.
2	A man offers a pen to a woman, saying “Ladies, first.”	An example of benevolent sexism.	A man gives pens to both a man and woman at the same time.
3	A man asks a woman to take the secretarial role of note-taker.	Women primarily support men’s work in STEM and adopt stereotypic roles such as secretary.	A man volunteers to take notes.
4	Students discuss being in research studies.	None; Neutral interaction	Students discuss being in research studies.
5	A woman’s idea is ignored until a man repeats it and is given credit for it.	Men are more credible sources of good ideas in STEM than women.	A woman’s idea is discussed and accepted.
6	Students discuss their summer vacations.	None; Neutral interaction	Students discuss their summer vacations.
7	A woman volunteers ideas but the men speak over her.	Women’s STEM contributions are not as important as men’s contributions.	A woman volunteers ideas without being spoken over.
8	Students discuss their internet research.	None; Neutral interaction	Students discuss their internet research.
9	A woman enthusiastically shares her experience and ideas and is accused of taking over the team meeting and is asked to step back and allow others to share.	Men should be dominant and women should be warm.	A woman enthusiastically shares and other team members listen and add to her ideas.
10	A man explains a concept to a woman after she states that she is already familiar with the concept.	Men have better understanding of STEM concepts than women do.	A man and a woman discuss a concept that they are both familiar with.
11	A woman reads the project instructions and requirements to the group.	None; Neutral interaction	A woman reads the project instructions and requirements to the group.

The biases used in the script include assumptions of women's inferiority in engineering, benevolent sexism, treating women as second-class citizens, acknowledging a woman's idea only when it is repeated by a man, interrupting women, women being seen as bossy, and explaining something to a woman in a condescending manner. Video clips of each of the scenes were produced and embedded into surveys for pre-testing to identify clips that met the goals of being believable while also demonstrating differences associated with the two conditions (i.e., being perceived as reflecting gender stereotyping or bias and being perceived as disrespectful or negative).

Pretesting data was collected from 119 college students majoring in a STEM field (81 men, 38 women) who viewed and answered questions about the video clips in an on-line survey. Participants were randomly assigned to view seven bias, or seven control video-recorded group interactions, plus each group saw the four neutral filler interactions. Participants rated the video clips on the degree to which they reflected gender stereotyping, gender bias, were positive interactions; were respectful, typical of college students, believable, interesting, and easy to follow. ANOVAs were conducted to examine the effects of participant gender, condition (bias or control), and their interaction.

Figure 2 displays microaggression (subtle bias) stereotype bias ratings by participants of all twelve scenes for both the bias and control video clips.

Figure 2

Pretest Ratings of Video Clips for Level of Gender Stereotyping or Bias

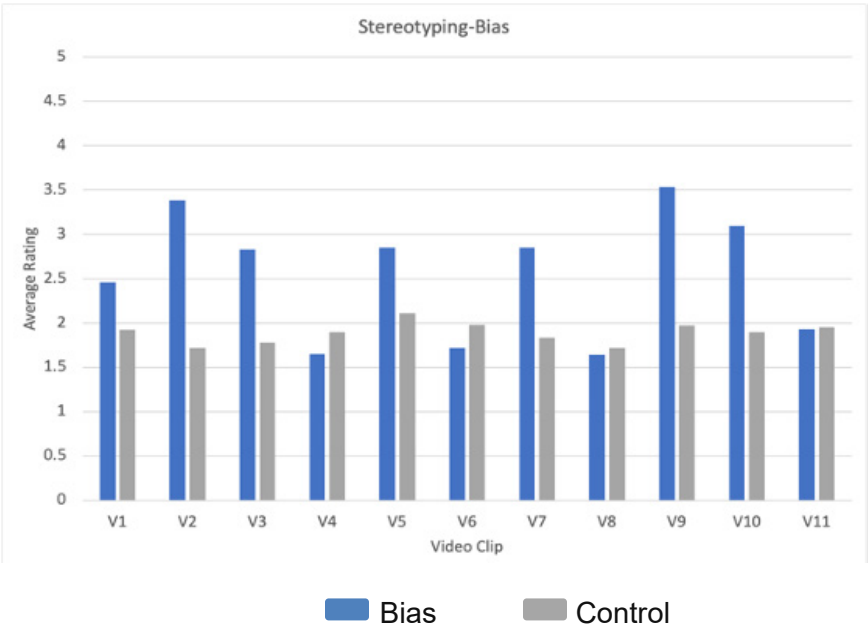


Figure 3 displays levels of respect and positivity ratings by participants of all twelve scenes for both the bias and control video clips.

Figure 3

Pretest Ratings of Video Clips for Level of Respect and Positivity

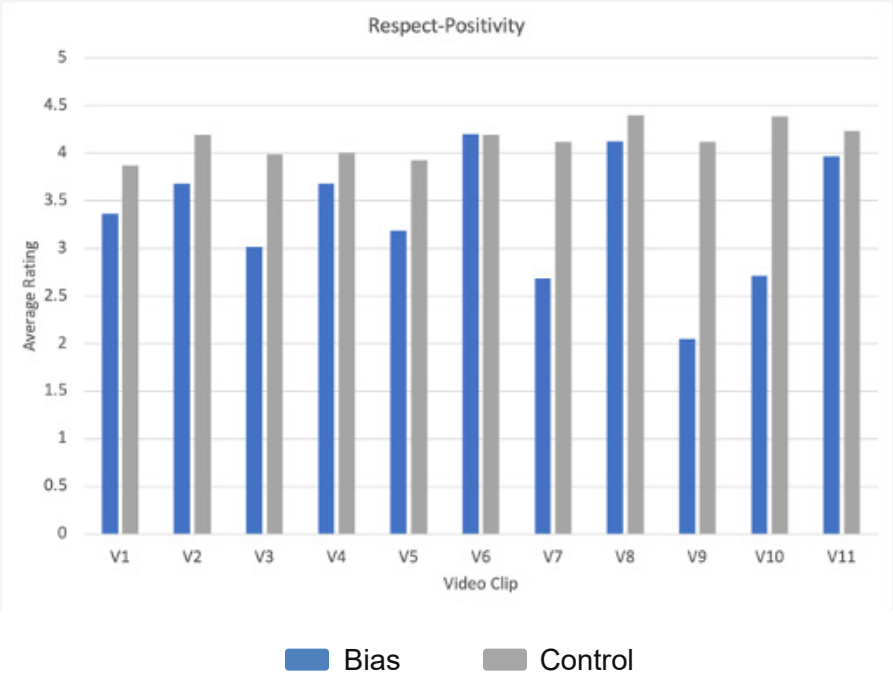
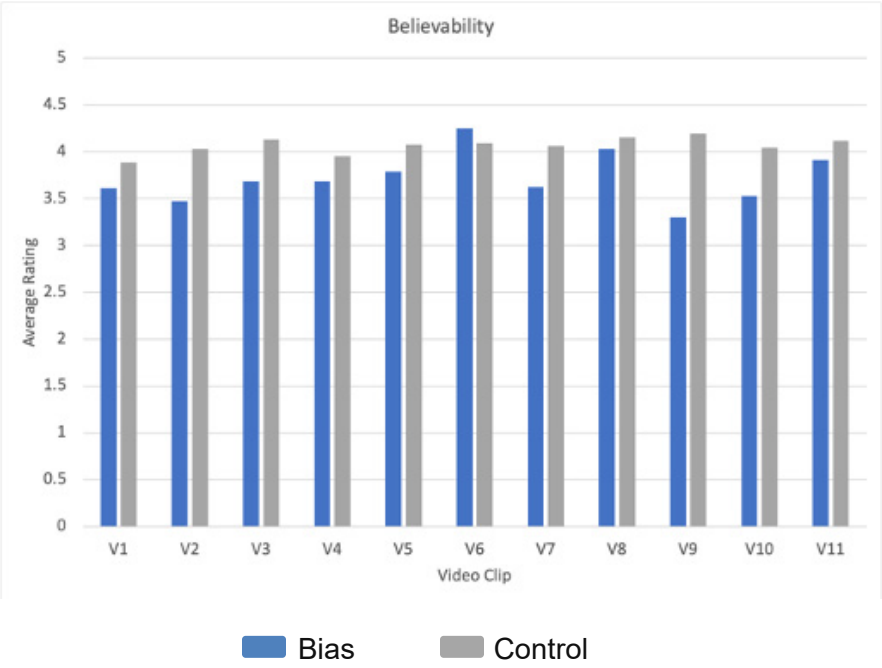


Figure 4 displays believability ratings by participants of ratings by participants of all twelve scenes for both the bias and control video clips.

Figure 4

Pretest Ratings of Video Clips for Level of Believability



Results revealed that scenes 2 and 9 were less believable across conditions, so these two scenes were dropped from the videos, the five remaining bias and control scenes shared similar high ratings for believability with significant differences across their demonstration of stereotyping bias, and level of respect/positivity. For the final versions of the videos, the clips were arranged in the following order: 3, 4, 5, 6, 7, 1, 8, 10, 11. The final scripts for both videos can be found in Appendix A. Table 4 reflects a final summary of the five bias events that were included in the manipulation video. The common names will be referenced in all three studies of this dissertation.

Table 4

Final Bias Video Scenes Including Underlying Stereotype and Common Name Used Herein

Bias Event Number	Bias Version	Stereotype Reflected	Common Name
1	A man asks a woman to take the secretarial role of note-taker.	Women primarily support men's work in STEM and adopt stereotypic roles such as secretary.	Note-Taking
2	A woman's idea is ignored until a man repeats it and is given credit for it.	Men are more credible sources of good ideas in STEM than women.	Hepeating
3	A woman volunteers ideas but the men speak over her.	Women's STEM contributions are not as important as men's contributions.	Interrupting/Talking Over
4	A man expresses his surprise that a woman is in a more advanced calculus class than he is.	It is unusual and unexpected for women to be highly competent in STEM.	Questioning Competence
5	A man explains a concept to a woman after she states that she is already familiar with the concept.	Men have better understanding of STEM concepts than women do.	Mansplaining

Scales

Recognition of Subtle Bias as Stereotyping

Participants completed open-ended measures of recognition of subtle bias as gender stereotyping. Participants were asked to think back on the video they saw earlier in the study and describe the interactions; independent judges scored them as to whether they reflected recognition of stereotyping.

Additionally, participants completed closed-ended measures of bias recognition where they were asked to rate the interactions between students in the video on the degree to which they were perceived to be influenced by gender bias, gender stereotyping and sexism. Participants responded to these three items on a 1 - 7 Likert

scale ranging from 1 “not at all influenced by [gender bias/gender stereotyping /sexism]” and 7 “extremely influenced by [gender bias/gender stereotyping/sexism]”, Chronbach α = .95.

Explicit STEM Stereotype Endorsement Scale

This scale included three items adapted from Schmader et al. (2004) based on stereotypes that men are more suited to STEM than women (e.g., “In general, men may be better in science and engineering than women”). Participants responded to all items on a 1-7 Likert scale with 1 being “strongly disagree” and 7 being “strongly agree”, Chronbach α = .79.

Explicit General Stereotype Endorsement Scale

Developed by the researchers of this project (derived from the Explicit STEM Stereotype Endorsement Scale), this scale included three items based on general traits stereotypically associated with men and women (e.g., “Men are naturally assertive and ambitious”; “Women are naturally submissive and caring”). Participants responded to all items on a 1-7 Likert scale with 1 being “strongly disagree” and 7 being “strongly agree”, Chronbach α = .66.

Science and Gender Implicit Attitude Test (IAT)

The IAT (Greenwald et al., 1998) is used to measure science and gender implicit stereotype beliefs. The test paired “men” (e.g. man, boy, father, uncle) with “science” (e.g. mathematics, engineering, chemistry) and “women” (e.g. woman, girl, mother, wife) with “humanities” (e.g. English, arts, history) and vice versa. Scores are calculated based on time spent on questions and converted into a single D-score for analysis which showed if they had a slight preference for one of the pairings - a positive score

represented an association between men and science whereas a negative score represented an association between women and science. Chronbach α = 0.7 to 0.9

Gender Based Rejection Sensitivity Scale (GBRS)

The GBRS (London et al., 2012) measures an individual's concern about and expectations for being excluded, marginalized, or disrespected on the basis of gender. The GBRS provides six scenarios and two questions measuring concern/anxiety about experiencing gender bias, and one's perceived likelihood that a gender biased outcome would occur. For example, "Imagine that you have to give an oral presentation in a very important course. After everyone gives their presentations, the professor announces that he will post the grades outside of the classroom.," followed by "How concerned/ anxious would you be that you might receive a lower grade than others because of your gender," and "I would expect to receive a high grade on the presentation." Items measuring concern about being excluded were answered on a 1-7 Likert scale ranging from 1 "very unconcerned" to 7 "very concerned", and items measuring expectations for being excluded were answered on a 1-7 Likert scale ranging from 1(not at all likely) to 7(very likely). GBRS scores were computed following the standard rubric [33], Chronbach α = .83.

Sexism Sensitivity Scale

The sexism sensitivity scale is an alternative measure developed by the researchers of this project to measure a participant's individual vigilance for gender bias events. There are six items on a 1-7 Likert scale ranging from 1 "strongly disagree" to 7 "strongly agree". The scale includes items such as, "In general, I think people of my gender are not taken seriously," Chronbach α = .89.

Negative Emotionality (NE)

The negative emotionality scale (Waller et al., 1996) measures an individual's general tendency to experience aversive emotions including anxiety, moodiness, and perceived victimization. There are items on a 1-7 Likert scale ranging from 1 “strongly disagree” to 7 “strongly agree”. Example items include statements such as, “I worry about terrible things that might happen,” Chronbach α = .89.

Measures

Outlined in Table 5 are a list of the measures used for this study.

Table 5

Study 1 Predictors, Dependent, and Control Measures

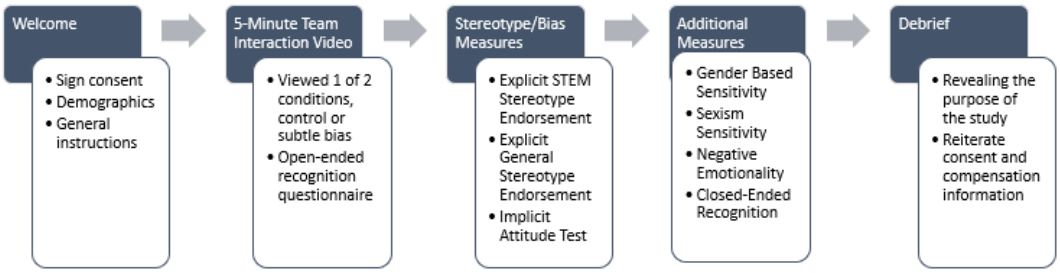
Predictors	Dependent Measures	Control Measures
Men and Women	Science/Gender IAT (Implicit Association Test)	Gender Based Rejection Sensitivity Scale
Bias Video and Control Video	Explicit General Stereotype Endorsement Scale	Sexism Sensitivity Scale
Open-Ended Bias Recognition	Explicit STEM Stereotype Endorsement Scale	Negative Emotionality Scale
Closed-Ended Bias Recognition		

Procedure

The study protocol included five main sections: welcome, 5-minute team interaction video (control or bias) and observations, stereotype and bias measures, additional measures, and a debrief. Figure 5 provides a visual flow diagram of the study.

Figure 5

Study 1 Procedure Diagram



Welcome

The study was conducted via the Qualtrics survey platform. On the welcome screen participants were told to imagine that they would be joining the team they were to view in a video described as an example of how previous groups have worked together on this task.

5-Minute Team Video Interaction

Following this introductory section, participants were randomly assigned to view one version of the video, being told that the study concerns testing their memory for videotaped interactions. Participants were then told that we were interested in perceptions of people engaged in social interactions in an academic science setting. Prior to starting the survey, participants were asked to ensure that they were in a quiet space and able to focus throughout the duration of the survey. They were informed that they would watch a previously recorded video for 4 minutes and 30 seconds which shows four undergraduate students working on a group project in engineering. After viewing the video participants were asked three open-ended questions 1) Their overall impressions of the team interactions in the video. 2) Please describe any positive events that stood out to you and 3) Please describe any negative events that stood out to you.

Stereotyping/Bias Measures

After the video and open-ended questions, participants were told that they would complete several questionnaires about themselves and their attitudes, prior to answering questions about the video. These measures included the Science and Gender Implicit Attitudes Test, Gender-Based Rejection Sensitivity, Sexism Sensitivity and Negative Emotionality. These measures are all described below. After this, participants were asked several video attribution questions such as their rating (on a 7-point Likert scale) of how positive, negative, and respectful the interactions were. They also rated (on the same scale) how much the interactions were influenced by gender bias, gender stereotyping, and sexism and to complete a brief explanation of why they answered these questions the way they did.

Debrief

Participants then read a debriefing summary which notified them that the purpose of the survey was to examine awareness of gender bias in STEM fields and that they were randomly assigned to videos that either displayed gender bias and stereotyping or displayed neutral interactions. The survey took approximately 20 minutes to complete, and participants were given a $15 Amazon gift card as compensation for completing the survey.

Data Analysis

A regression analysis was performed for each outcome, explicit (general & STEM) stereotype endorsement, and implicit stereotyping, by regressing each outcome variable on video condition, participant gender, recognition of subtle gender bias as gender stereotyping, and their interaction terms.

The study used a 2(video condition: bias/control) x 2(attribution to stereotyping: high/low) x 2(gender: man/woman) between-subjects design. Measures included recognition of subtle gender bias as gender stereotyping (close-ended and open-ended assessments), explicit stereotype endorsement, and implicit stereotyping (gender-science IAT). Covariates included Sexism Sensitivity and Negative Emotionality. We eliminated GBRS from the analysis as it was a similar predictor as Sexism Sensitivity, and the two instruments were correlated.

Results

Study 1 Participant Recognition of Subtle Bias Events

Utilizing a coding rubric (see Appendix B), the open-ended responses regarding participants' perceptions of gender bias within the video were coded by a team of three research assistants for recognition of bias. There were three rounds of coding total. In the initial round of coding, coders assessed the first 40 participant responses, with reliability for all variables except four being above the "Good" threshold of 0.80 of Cronbach's alpha values. The three coders met to discuss the first forty responses as well as address coding inconsistencies. Thereafter, coders were assigned participant responses 41-80 to code independently. An interrater reliability of above .80 was achieved across all variables falling within the "Good" range of Cronbach's alpha values. The rest of the participant responses were independently coded after the coders met to discuss interrater reliability.

The open-ended coding consisted of 102 women and 117 men who witnessed the bias condition video. Table 6 outlines the breakdown of detection characteristics of the participants based on the five subtle bias events depicted in the video. Both genders were categorized based upon 1) no recognition of the bias event, 2) recognition of the

event, but didn't identify it as a bias interaction, and 3) recognition of the event and identified it as a bias interaction.

Table 6

Study 1 Numbers and Percentages of Participants in the Bias Condition Who Recognized and Labeled Bias Events by Gender

Event	Men			Women		
	No Recognition *n (%)*	Recognized, no bias *n (%)*	Recognized, bias *n (%)*	No Recognition *n (%)*	Recognized, no bias *n (%)*	Recognized, bias *n (%)*
1: note-taking	110 (94%)	0 (0%)	7 (6%)	82 (80%)	2 (2%)	18 (18%)
2: hepeat	74 (63%)	5 (4%)	38 (32%)	44 (43%)	7 (7%)	51 (50%)
3: interrupt/ talking over	44 (38%)	21 (18%)	52 (44%)	47 (46%)	6 (6%)	49 (48%)
4: questioning competence	102 (87%)	10 (9%)	5 (4%)	81 (79%)	8 (8%)	13 (13%)
5: mansplain	74 (63%)	2 (2%)	41 (35%)	49 (48%)	1 (1%)	52 (51%)
Overall: at least 1 event	17 (15%)	17 (15%)	82 (70%)	13 (13%)	8 (8%)	79 (77%)

Note: Men in bias condition (n=117) and Women in the bias condition (n=102).

Overall, the men in this study were least successful at recognizing bias in the questioning competence (5 participants) and note-taking (7 participants) events. They had the most success recognizing bias in the interrupt/talking over (52 participants) and mansplain (41 participants) events. Similarly, the women were least successful at recognizing the same bias events as the men, questioning competence (13 participants) and note-taking (18 participants), but had higher recognition compared to the men. While the women had the most success at recognizing the mansplain (52 participants) and hepeat (51 participants) events. Comparably, 70 percent of the men recognized at least one bias event, while 77 percent of the women recognized at least one bias event. It is

also interesting to note that interrupt/talking over was the only bias event where the women had a higher percentage of “no recognition” than the men.

Regressions

Recognition of bias was assessed in three ways: Closed-ended (responses lie on a 1 - 7 Likert scale ranging from 1 “not all influenced by [gender bias]” and 7 “extremely influenced by [gender bias]”); Open-ended dichotomous score (using yes/no recognition of bias in open-ended responses); and Open-ended continuous score (using a count score of the number of times respondents indicated recognition of bias in open-ended responses). Few statistically significant outcomes emerged using the open-ended assessments, perhaps because people on average recognized very few events based on the continuous score. However, most people recognized at least 1 event of bias based on the dichotomous score, thus the variance in these variables was minimal. Significant results emerged primarily regarding closed-ended assessment of recognizing bias. Additionally, none of the control variables significantly related to the outcomes.

Explicit General Stereotype Endorsement

Results of the regression analysis for explicit general stereotype endorsement (overall $M = 3.13$, $SD = 1.10$) revealed no significant main effects or interactions. See Table 7 for detailed regression analyses.

Table 7

Regression Results for General Stereotype Endorsement

Model	Variable	Unstandardized B	Coefficients SE B	β	*t*	*p*
1	Sexism Sen.	.088	.064	.108	1.379	.169
	GBRS	-.090	.098	-.071	-.911	.363
	Neg. Emotionality	-.038	.059	-.037	-.637	.525
2	Sexism Sen.	.097	.076	.119	1.278	.202
	GBRS	-.084	.100	-.066	-.833	.405
	Neg. Emotionality	-.044	.060	-.043	-.734	.463
	Gender	-.103	.275	-.043	-.376	.707
	Condition	.346	.267	.143	1.297	.195
	Closed-Ended Bias	-.044	.089	-.067	-.496	.620
	ConditionxGender	-.063	.350	-.023	-.179	.858
	ConditionXClosed Bias	-.147	.139	-.138	-1.060	.290
	GenderXClosed Bias	-.060	.124	-.066	-.489	.625
	ConditionxGenderXClosed Bias	.075	.185	.051	.404	.687

Note: *N* =404. Results of the regression analyses for general stereotype endorsement revealed no significant main effects or interactions. $p < .001$.

Explicit STEM Stereotype Endorsement

Results of the regression analysis for explicit STEM stereotype endorsement (overall $M = 2.00$, $SD = 1.21$) revealed a significant main effect of condition, $B = .54$, $t = 2.07$, $p = .04$, such that participants reported greater explicit stereotype STEM endorsement in the bias ($M = 2.28$) than the control condition ($M = 1.95$). This main effect was qualified by a significant condition by recognition of stereotyping interaction, $B = -.27$, $t = -2.02$, $p = .04$. See Table 8 for detailed regression analyses.

Table 8

Regression Results for Explicit Stereotype Endorsement

Model	Variable	Unstandardized B	Coefficients SE B	β	*t*	*p*
1	Sexism Sen.	-.115	.064	-.141	-1.798	.073
	GBRS	.044	.098	.035	.448	.654
	Neg. Emotionality	.016	.059	.016	.272	.785
2	Sexism Sen.	-.006	.074	-.007	-.075	.940
	GBRS	.095	.098	.075	.977	.329
	Neg. Emotionality	-.007	.058	-.007	-.115	.909
	Gender	.487	.267	.201	1.824	.069
	Condition	.536	.260	.221	2.067	.039
	Closed-Ended Bias	.005	.086	.008	.063	.950
	ConditionxGender	-.359	.340	-.131	-1.056	.292
	ConditionXClosed Bias	-.273	.135	-.255	-2.022	.044
	GenderXClosed Bias	-.125	.120	-.137	-1.039	.300
	ConditionxGenderXClosed Bias	.104	.180	.071	.581	.562

Note: *N*=404. Results of the regression analyses for explicit stereotype endorsement revealed a significant main effect of condition and a significant condition by recognition of stereotyping interaction. $p < .001$.

Simple effects analyses revealed that among those who did not recognize stereotyping in the video, explicit STEM stereotype endorsement was higher in the bias than control video condition, consistent with the main effect of condition. However, among those who did recognize stereotyping in the video, explicit STEM stereotype endorsement was not different between bias and control video conditions, Moreover, in the control condition, explicit STEM stereotype endorsement was not significantly different between those who recognized less stereotyping in the video (-1 *SD*) and those who recognized more stereotyping in the video (+1 *SD*). In the bias condition, explicit STEM stereotype endorsement was higher among those who recognized less stereotyping in the video (-1 *SD*) compared to those who recognized more stereotyping

in the video (+1 *SD*). As reflected in Table 9, this pattern suggests that viewing the bias video increases explicit STEM stereotype endorsement, but those who recognize stereotyping in the video temper their explicit STEM stereotype endorsement ratings. Put another way, witnessing subtle bias events led observers to endorse stereotypes that men are better suited for STEM than women, but only if they did not label the event as gender stereotyping; if they did label the event as gender stereotyping, they explicitly disowned the STEM stereotype.

Table 9

Explicit STEM Stereotype Endorsement by Video Condition and Level of Recognizing Stereotyping in the Video

Recognition of stereotyping	**Video Condition**		
	Control	**Bias**	
-1 SD (did not recognize stereotyping)	2.08	2.77	*b* = .69 *t* = 2.98 *p* = .003
+1 SD (did recognize stereotyping)	1.81	1.79	*b* = -.02 *t* = -.10 *p* = .92
	b = -.07 *t* = -1.21 *p* = .23	*b* = -.26 *t* = -4.16 *p* = .000	

Note: *N*=404. Results of the control condition, was not significantly different between those who recognized less stereotyping in the video and those who recognized more stereotyping. In the bias condition, explicit STEM stereotype endorsement was higher among those who recognized less stereotyping in the video compared to those who recognized more stereotyping in the video.

Taken together, these results suggest that the effect of witnessing subtle bias events on stereotype endorsement are specific to the stereotype that men are better suited to STEM than women, not to stereotypes about men's and women's general traits (e.g., men as naturally assertive; women as naturally submissive). An unanticipated result for the data was that participants recognized bias in the control, when of the scenes in that video were intended to contain all neutral interactions.

Implicit Stereotype Endorsement

Results of the regression analysis for implicit stereotyping (IAT) revealed a significant main effect of gender, such that women (M = .47) demonstrated greater implicit stereotyping than men (M = .09), B = -.45, t = -5.33, p < .001. A significant main effect of condition also emerged, such that participants demonstrated greater implicit stereotyping in the control (M = .27) than bias condition (M = .21), B = -.17, t = -2.00. p = .047. No other significant effects emerged, See Table 10 for detailed regression analyses.

Table 10

Regression Results for Implicit Stereotype Endorsement

Model	Variable	Unstandardized B	Coefficients SE B	β	*t*	*p*
1	Sexism Sen.	.054	.018	.194	2.976	.003
	GBRS	.010	.066	.090	1.517	.130
	Neg. Emotionality	.077	.019	.021	.377	.076
2	Sexism Sen.	-.035	.022	-.127	-1.634	.103
	GBRS	8.151e-6	.006	.000	.001	.999
	Neg. Emotionality	.024	.018	.068	1.286	.199
	Gender	.460	.087	.556	5.292	<.001
	Condition	-.171	.084	-.206	-2.042	.042
	Closed-Ended Bias	-.006	.028	-.026	-.209	.834
	ConditionxGender	.174	.109	.187	1.593	.112
	ConditionXClosed Bias	.113	.081	.166	1.391	.165
	GenderXClosed Bias	-.056	.072	-.096	-.769	.442
	ConditionxGenderXClosed Bias	-.044	.108	-.048	-.413	.680

Note: Results of the regression analyses for implicit stereotyping (IAT) revealed a significant main effect of gender and significant main effect of condition. $p < .001$.

Discussion

The primary goal for this study was to examine the relationship between the ability to recognize subtle bias events as being based on gender stereotypes and stereotype endorsement. Participants viewed a video that showed subtle gender bias events in an engineering team setting, or a neutral video, and then completed three stereotype endorsement measures.

Participants completed open-ended and closed-ended measures of recognition of subtle bias as gender stereotyping. For the open-end measures, an open-ended dichotomous score and open-ended continuous score was used. Participants were asked to think back on the video they saw earlier in the study and describe the interactions; independent judges scored them as to whether they reflected recognition of

stereotyping. Few statistically significant outcomes emerged using the open-ended assessments, perhaps because the mean scores for recognizing stereotyping on this assessment were very low, with most participants scoring zero (i.e., did not spontaneously report stereotype recognition). Therefore, results focused only on the close-ended recognition of stereotyping assessment.

Two measures were used to evaluate explicit stereotype endorsement - one concerning broad traits stereotypically associated with gender, and one concerning stereotypes about men's superior suitability for STEM. Analyses of the explicit general stereotype revealed no significant main effects or interactions, while the STEM measure revealed a significant main effect of condition. The final stereotype endorsement measure was implicit stereotyping (IAT). Assessments using implicit measures are designed to reduce control over responding. Analyses of the IAT scores showed few significant effects, perhaps because implicit associations are more difficult to change given their uncontrollable nature. Therefore, results focused on explicit stereotype endorsement measures.

Using these explicit STEM stereotype endorsement measures allowed us to capture the degree to which participants believed these gender stereotypes are true and valid. The measures provided participants the opportunity to explicitly reflect on their beliefs when responding, thus granting them a measure of control when responding. This allowed participants to explicitly disown gender stereotypes as true and valid if they so desire. The regression analyses performed for explicit STEM stereotype endorsement's relationship with recognition of subtle bias events as gender stereotyping showed that participants reported greater belief in the validity of these stereotypes after witnessing subtle gender bias events in the video compared to when they did not see

subtle bias events based on gender in the video. These results show that simply witnessing subtle gender bias events can increase conscious endorsement of gender stereotypic beliefs about men's superior suitability in STEM. This was true across participant gender, illustrating that both men and women alike may endorse STEM stereotypes as a consequence of witnessing subtle gender bias. Although not measured here, these activated stereotypes could (consciously or subconsciously) lead witnesses to engage in subtly stereotypic behaviors themselves, with a negative effect on those around them.

However, the main effect of video condition on explicit STEM stereotype endorsement was qualified by a significant interaction between video condition and recognition of stereotyping. When watching the video with no subtle gender bias events (control video), there was no difference in how strongly participants endorsed STEM stereotypes based on recognition of stereotyping. When watching the video with subtle gender bias events, though, those who recognized the subtle gender bias events as stereotyping reported weaker endorsement of STEM stereotypes compared to those who failed to recognize the subtle gender bias events as stereotyping. In other words, participants who saw subtle bias and failed to recognize it as such had significantly greater explicit endorsement of STEM stereotypes than both those who saw subtle bias and recognized it as stereotyping and those who did not see bias at all (control video). Of interest, this pattern emerged only regarding explicit STEM stereotype endorsement (regarding stereotypes of men's greater suitability for STEM than women), as opposed to explicit general gender stereotype endorsement (regarding stereotypes of men being assertive and women being caring), which likely emerged because the subtle bias

events witnessed occurred in the STEM context regarding STEM-specific gender stereotypes.

Considering that our primary outcome measure involved a self-report assessment of stereotype endorsement, one could argue that those who recognize bias and subsequently explicitly reject stereotypes are simply misrepresenting their beliefs to appear as "politically correct" to the researchers or society. While this is a criticism affecting all self-report measures, it may be particularly relevant to assessment of stereotype endorsement. Yet, even if people are engaging in this type of socially desirable response, there is likely still great value in their choice to represent themselves as non-biased people. Previous research has shown that self-awareness regarding one's own biases/prejudices, and a desire to reduce them, are important first steps in being able to actually reduce those same biases/prejudices (Devine et al., 2012). Thus, when individuals have the ability to recognize bias, they therefore have the opportunity to consciously reject those biases, which can help contribute to a more inclusive environment for all.

Limitations

It is interesting to note that despite the interactions depicted in the control video, some participants still perceived a degree of gender bias in the control video (evidenced by the average rating of recognition of bias being 1.94 in the control condition, as opposed to the lowest possible value of 1.0, "not at all influenced by gender bias/ discrimination/ sexism"). This may be due to several influences, for example, the perception that all mixed gender interactions are likely influenced by attitudes about gender, at least to some degree; or that people who spend significant time in STEM settings may commonly encounter stereotyping which makes them highly vigilant for

perceiving gender bias. For example, in a 2012 study, researchers found that when people are given feedback about their progress in areas of egalitarian efforts, they detect bias at a higher level than individuals who were not offered feedback (Mann & Kawakami, 2012). Another plausible explanation for this result is collective threat, in that one's psychology can be impacted by the actions, emotions, and thoughts of their fellow in-group members (Cohen & Garcia, 2005). Within the context of this line of research, this might be an in-group member's fear that others like them (i.e., white men in STEM) behave badly by reinforcing negative stereotypes (i.e. subtle gender bias). Future research should explore the individual differences that may lead individuals to perceive bias when witnessing (relatively) neutral events.

Another limitation of this study was that it was an online, self-paced project. Although attempts were made to ensure participants were focused and intentional during the study, we rely on their honesty to focus and be attentive. Participants were removed for various reasons related to not being attentive or engaged, i.e. to not giving their best effort in this study or not fully completing the survey. These types of limitations can be minimized when in-person studies are leveraged.

It is important to recognize that the current study focused on subtle bias events based on gender. However, other social identity groups are also negatively stereotyped and underrepresented in STEM, including racial/ethnic minorities (i.e. Native American, African American, Latinx people), and sexual minorities (including LGBTQ individuals) (Williams et al., 2015; Cech & Waidzunas, 2021). In addition, this study utilized a binary view of gender, and did not present any findings regarding people who identify otherwise (i.e.non-binary, gender fluid, etc.). Future research should broaden the range of social

identity groups included, to increase understanding of how witnessing and recognizing bias affects individuals more broadly.

Future Work

Future research in this direction will include a shift from dependent measures of self-perception and self-report to behaviors indicative of gender stereotype endorsement, such as evaluations of men's vs. women's STEM performances, selecting STEM team members, or assigning roles on a team. This will show whether awareness might influence not only a tempering of self-report but tempering of behaviors that reinforce stereotypes as well.

Finally, although it wasn't the primary focus of this research project, it may also be interesting to explore why some individuals detected bias in the control video. This raises the question whether accumulated bias experiences influence one's ability to objectively witness a STEM team interaction.

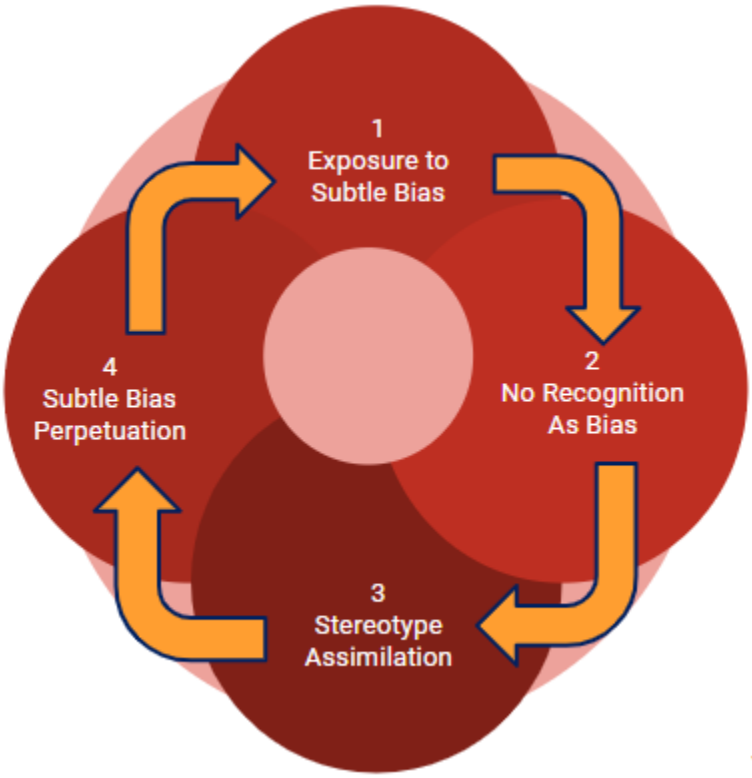
Conclusions

This study examined how an ability to recognize subtle bias as stereotyping can reduce the endorsement of gender stereotypes that is raised when people witness subtle bias happening around them. Results supported the conceptual model in Figure 2, suggesting that simply witnessing subtle gender bias events can increase conscious endorsement of gender stereotypic beliefs for both men and women. Additionally, those who witness bias and do not recognize it as stereotyping appear to have stereotypes activated which leads to greater explicit endorsement of stereotypes compared to those who did not witness bias. In other words, if bias is recognized, in terms of explicit endorsement of STEM stereotypes, it is as if the bias didn't happen.

These findings highlight the importance of being able to recognize subtle bias events as stereotyping. Figure 6 helps to visual the recursive process on non-recognition, first there is an exposure to subtle bias events. An important second step is whether the observers of bias are able to recognize and identify the subtle bias events as gender stereotyping. When there isn't recognition, stereotype supporting behaviors or assimilation happens. Consequently, subtle gender bias behaviors and actions can be perpetuated, replicated, and reinforced in the environment (most often at a higher level) and ultimately cycle of subtle bias is perpetuated in the environment. Thus, recognition of bias potentially serves the role of blocking a recursive process which may reduce the propagation of STEM gender stereotypes, degradation of the climate for women in STEM, and negative outcomes for all involved in this setting.

Figure 6

Understanding Subtle Gender Bias Recognition in a STEM Educational Setting



Note: When individuals do not recognize subtle bias events as gender stereotyping, stereotype assimilation happens, and subtle bias is perpetuated in the environment.

While some individuals are the direct targets of bias, many others may be witness to this bias. Indeed, it is likely that more people witness subtle bias in workplace and academic settings every day than are direct targets of bias themselves. Being able to recognize that bias happening in one's environment is a manifestation of stereotyping can lead people to endorse stereotypes less strongly, thus potentially creating the opportunity for them to choose to avoid discriminatory behavior themselves. This lends credence to the utility of training programs and other educational interventions that teach individuals about stereotypes, subtle bias, and how to recognize when it is happening

around them. Previous research has found that bias education programs can reduce implicit bias, increase awareness of bias, and reduce instances of bias (Devine et al., 2012; Moss-Racusin et al., 2018). Further, research into STEM specific bias education programs has shown that they help to increase the retention rates of women in STEM and that these effects are persistent over time (Moss-Racusin et al., 2018). This research suggests that such programs may result in more people being able to recognize stereotyping, and thus be able to reject activated stereotypes when they witness subtle gender bias in their environment. This may break the negative recursive cycle in which witnessing bias begets more stereotype endorsement and more gender discrimination, which may ultimately help improve the climate in STEM settings.

These results are important and relevant to how we educate and develop future engineering professionals. Having a greater understanding of how gender biases (even in subtle expressions) affect one's ability to work, collaborate, and support others in an academic setting provides valuable insight into the creation of supportive environments for women in engineering. Individuals who were able to identify subtle bias events were in a position to believe in or defy gender stereotypes when they witnessed them first-hand. The model proposed here suggests there is value in open discourse of the issues of stereotyping and bias in STEM, as individuals may learn more about how to recognize bias. Having this ability could allow them to make more egalitarian, or stereotype-defying behavioral choices when choosing partners for projects, assigning technical roles on teams, evaluating the contributions of others, and other common STEM activities. Utilizing the model, intervention methods and/or educational tools could be developed by STEM educators to provide STEM students with information and

resources about how subtle bias is evidenced in STEM settings, which can help them learn to recognize it and avoid it in their own behaviors and choices.

Previous research efforts show that women are commonly viewed to have lower status positions and are acknowledged for their abilities at a lesser degree than men in STEM (Wolfe & Alexander, 2005). However, this study did not aid us in understanding why these events weren't recognizable across both genders. Perhaps they are so common that students have normalized mental models related to women having better handwriting and men being better in math. The men in this study had the most success in recognizing the interrupt/talking over event, which could speak to the role gender plays in interpersonal interactions, especially in STEM fields. Furthermore, mansplain was a highly detected bias event for both men and women, perhaps due to its evolution as common social media vernacular. Research shows that there is an increased understanding and discussion of mansplaining actions in society (Lutzky & Lawson, 2019). The results related to bias detection in this study will inform consistencies and inconsistencies in the detection results in the other two studies of this dissertation. A deeper understanding of witnessing, recognizing, and interpreting subtle gender bias events is the focus of the third study of this dissertation.

Chapter 3 (Study 2) ~ Effects of Witnessing Subtle Bias and Attribution to Gender Stereotyping on Performance and Persistence

This study employed the subtle bias video materials (utilized in Study 1) to assess the effect of attributing a witnessed event to gender stereotyping or stereotype assimilation, and in this case, tests for reduced performance and persistence of women. The study includes a full replication of the recognition and attribution questions used in Study 1, along with additional measures to assess performance and persistence, as well as newly introduced measures of Grit (Duckworth et al., 2007) and Mental Toughness (Clough et al., 2002). Mental Toughness and Grit will be explored to further explain performance and persistence. According to prior research (Price, 2019) There may be some redundancy between the two instruments, but each of them also consists of unique features. Grit is oriented with effort and passion toward a long-term goal, while Mental Toughness is related to the ability cope and manage stress levels during difficult situations, thus Mental Toughness could potentially alter one's perception of stress and result in an adaptive use of the elevated stress to perform (Satterwhite, 2016). Having a balance (or combination) of both Grit and Mental Toughness may adaptively allow students to manage stressful situations, such as performance and completion of the spatial ability test. In a previous study on predictors of academic performance, Morris (2021) found that Mental Toughness was significantly negatively correlated with stress and significantly positively correlated with final exam scores. Confirming Satterwhite's (2016) results of the adaptive utilization of Mental Toughness during an acute difficulty.

Research Questions

The aim of this study is to address the following research questions:

R1: How does recognition of subtle gender bias events affect STEM student's performance and persistence?

R2: How does recognition of subtle gender bias events affect STEM student's perceptions of gender stereotypes?

We hypothesized that when participants witness subtle bias events, they are more likely to experience reduced performance and persistence, this will be especially true for women. However, recognition may protect women from these negative outcomes.

Methods

Participants

Participants were recruited via targeted email from the campus of Michigan Tech with a goal of 400 participants (200 women and 200 men) from majors with less than 30% women. To incentivize participants a $20 amazon gift card was offered after completion of the study session. Despite the presence of over 500 women and 3000 men in the original participant pool, response rates were low. This was likely due to the running of this study during a global pandemic which greatly reduced participant interest. To maintain a single-institution pool, the recruitment pool was opened-up to any STEM majors on campus (not just those with < 30% women enrolled), reasoning that the campus itself stands at < 30% women overall and the study was extended for an additional semester. 411 participants completed the webinar. One graduate student participant was removed from the study. Another participant was removed due to technical difficulties with sound during the video. Three participants were removed because they had participated in the webinar more than once. Eleven additional participants were removed due to a lack of attention throughout the duration of the study, or they mistakenly overheard the researchers and/or viewed a slide during the webinar

that would have otherwise distorted their responses related to detection of subtle bias. Twenty-five participants were removed from the data set because they identified as non-binary gender and the researchers utilized only participants identifying as men or women for the statistical analyses. The final sample size consisted of usable data from 370 participants. 176 identified as women (47.6%); 194 as men (52.4%); 312 as White (84.3%); 17 as Asian/Asian American (4.6%); 17 as multiracial (4.6%); 9 as Latinx (2.4%); 7 as Black (1.9%); 4 as Middle Eastern/North African (1.1%); 2 as Native American (0.5%); 2 as other race (0.5%). The mean age of the sample was 20.5 years old. The initial cohort of majors with less than 30% representation of women were from the following majors: Civil Engineering, Computer Engineering, Electrical Engineering, Mechanical Engineering, Mechanical Engineering Technology, Computer Science, General Computing, Software Engineering, Computer Networking and Systems Analysis, Cybersecurity, and Electrical Engineering Technology. To obtain our recruitment goal the following STEM majors were also recruited: Chemical Engineering, Environmental Engineering, Biomedical Engineering, Geological Engineering, Material Science and Engineering, Geospatial Engineering, Mining Engineering, Robotics Engineering, and Mechatronics. Table 11 shows the number of final participants in each condition by gender.

Table 11

Study 2 Participant Breakdown by Condition and Gender

	Men	Women	Total
Control Condition	97	86	183
Bias Condition	97	90	187
Total	194	176	370

Materials

The same video materials utilized in Study 1 were also used in this study.

Scales

The scales of Sexism Sensitivity and Negative Emotionality that were utilized in Study 1 were also used in this study. Additionally, the following scales were utilized in this study.

Spatial Ability Test

The Spatial Ability Test (Jäger and Althoff, 1983) scale measures the ability to visualize and manipulate 2-dimensional images into 3-dimensional shapes or objects. The test consists of 10 multiple choice questions requiring one to imagine how a 2-dimensional image can be folded into a 3-dimensional image. There were five possible answers from which to choose and 1 minute to answer each question before the survey automatically advanced to the next question. Each question was timed and scored. Two of the ten questions were “impossible to solve” questions. They were incorporated into the test to ensure no one obtained a perfect score. The impossible questions were important as they facilitated the corresponding persistence question.

Persistence on Test

After completing the spatial ability questions, a task-related persistence question was posed, asking if they would like additional spatial test questions to improve their score. Their response options were No; Yes, I'd like to try 1 more; Yes, I'd like to try 2 more; or Yes, I'd like to try 3 more.

Persistence in Field of Study Scale

This scale consists of 5 items on a 7-point Likert scale ranging from 1 “strongly disagree” to 7 “strongly agree.” The persistence scale measures and individual’s

intentions regarding their field of study. Each item corresponds to how strongly they would like to pursue their field such as, “I look forward to entering the workforce in my chosen field.”

Enthusiasm for Teamwork Scale

The Enthusiasm scale consists of 3 items on a 7-point Likert scale ranging from 1 “strongly disagree” to 7 “strongly agree.” This included questions regarding how participants feel about working with the group they witnessed in the video, for example “I would feel positive about the idea of working with this group.”

Stereotype Awareness Scale

The stereotype awareness scale consists of one multiple-choice question asking participants on the awareness of the stereotype regarding men and women’s math ability. The question was on a 7-point Likert scale ranging from 1 “men are much better than women” to 7 “women are much better than men.”

Grit (Grit-12)

Grit, the ability to persevere and remain focused on long-term goals (Duckworth et al., 2007) was assessed. The 12-item Grit scale consists of two subscales *Perseverance of Effort* (PE) and *Consistency of Interest* (CI) (Duckworth et al., 2007). PE reflects a person’s tendency to continue pursuit of long-term goals even when they are faced with challenges or setbacks. CI reflects a person’s tendency to remain goal-oriented and focused over prolonged periods of time (Duckworth & Gross, 2014). Answers on the Grit scale are given on a five-point Likert-type scale ranging from 1 “not like me at all” to 5 “very much like me”. Responses across items are averaged with a range of 1=not at all gritty to 5=extremely gritty. Internal consistency estimates (Cronbach's alpha) for the Grit scale were 0.85 (Duckworth et al., 2007). Sample

questions include “setbacks don’t discourage me” (PE) and “my interests change from year to year (CI)”.

Mental Toughness (MTQ-18)

The Mental Toughness Questionnaire (MTQ18; Clough et al., 2002) is reported to be a valid and reliable instrument, having high correlations with the longer MTQ-48 instrument, offering a robust measure of overall toughness (no subscales). Mental Toughness determines one’s ability to cope during stressful or challenging situations regardless of the circumstances. Answers on the MTQ-18 are given on a five-point Likert-type scale ranging from 1 “strongly disagree” to 5 “strongly agree”. Responses across items are summed, with higher scores reflecting greater MT (Cronbach’s alpha = 0.92; Clough et al., 2002). The abbreviated MTQ-18 produces a global unidimensional score; it doesn’t measure any subscales. Participants were instructed to think about how they are in general, and they were encouraged to not spend too much time on any one item. Sample questions include “even when under considerable pressure I usually remain calm” and “when I make mistakes I usually let it worry me for days after”.

Measures

Outlined in Table 12 are a list of the measures used for this study.

Table 12

Study 2 Predictors, Dependent, and Control Measures

Predictors	Dependent Measures	Control Measures
Men and Women	Spatial Ability Test Score	Stereotype Awareness Scale
Bias Video and Control Video	Persistence on Test	Sexism Sensitivity Scale
Open-Ended Bias Recognition	Persistence in Field of Study Scale	Negative Emotionality Scale
Closed-Ended Bias Recognition	Enthusiasm for Teamwork Scale	Grit Scale
		Mental Toughness Questionnaire

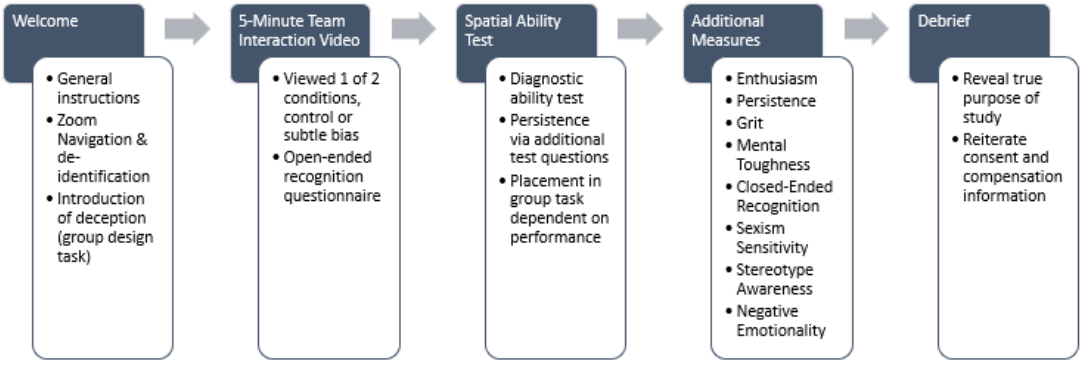
Procedure

This study was adapted for a synchronous online environment due to COVID-19 concerns. As such, participants attended a 1-hour Zoom webinar where they were told the cover story that researchers are studying the differences between in-person and remote teams. Targeted prospective participants were sent an electronic link of the IRB approved consent form in order to sign up for the study. The consent form included a deception statement; thus, students were notified that they would be misled about aspects of this study, but any deception used in this study will be minimal and cause no more harm or distress than experienced in day-to-day life, and will be explained at the end of the session. The form also included a list of upcoming session dates, and participants were asked to identify their availability for the webinar. Participants were notified via email of their scheduled webinar time, sent a Google calendar invitation, and sent an opt-in text notification 15 minutes prior to the start of their webinar appointment time. Researchers utilized a script and slides during the webinar to ensure that all participants experienced a consistent execution of the session. Two researchers were

present for each of the sessions, one to facilitate the study and the second to manage the webinar, such as monitoring attendance and managing the Q & A/Chat inquiries. Due to the webinar format in Zoom, the participants were only able to see the two researchers who were facilitating the session and were unable to see other participants. The webinar format was important to reinforce our cover story since participants were deceived to anticipate that they would be placed in teams during the session. The study included five main sections: welcome, 5-minute team interaction video (control or bias) and observations, spatial ability test, additional measures, and a debrief. Figure 7 provides a visual flow diagram of the study.

Figure 7

Study 2 Procedure Diagram



Note: Demographics were collected at time of consent to participate in the study

Welcome

Participants were immediately assigned a participant ID number to de-identify them and to maintain the confidentiality standards of the study. After a brief welcome and Zoom navigation instructions, participants were told that they would complete a group design task with a mixed gender group (this was the deception cue), but they'd first view a video described as an example of how previous groups have worked

together on this task. The purpose of introducing a group task to the study was to raise the expectation that participants would be working in a mixed gender team shortly.

5-Minute Team Video Interaction

Participants were then randomly assigned to view one version of the video (subtle bias or control) and then were asked to answer some questions about the video they viewed. These questions consisted of three open-ended questions identical to those used in Study 1, regarding their overall impression of the video as well as any positive or negative events that stood out to them during the video.

Spatial Ability Test

Next, they were instructed to complete a computer administered diagnostic test (Spatial Ability Test), described as a pre-assessment of skills needed for the upcoming group task. The test was intentionally not labeled as “spatial ability” as to not reinforce any spatial stereotypes regarding women performing worse than men on these types of tasks. Participants were told that their performance on the test would be used to place them into their team. Identifying this test as diagnostic and time limited raised the stakes on the test such that stereotype threat might become evident if stereotype concerns were activated among the participants. The test was timed, and participants had one minute to answer each question. Questions auto advanced after 1 minute. Two items on this ten-item test were impossible to solve (i.e., a mental rotation problem with no correct answer choice). Performance was assessed in terms of correct responses to the solvable test items. In addition, time spent (as recorded by the computer) on the impossible items was recorded. As a second measure of task-related persistence, participants were asked If they were interested in attempting additional spatial awareness questions before they are assigned to their teams to potentially increase their

score. Although participants were never actually offered additional questions, this question was asked to determine the participant's interest in improving their performance.

Additional Measures

To complete the survey portion of the study, participants were then told that they would answer some questions about their attitudes regarding various social issues. Once all participants notified researchers that they had completed the survey, they were informed that they would not actually join a group and that the experiment would be ending.

Debrief

To conclude the study, researchers began the debriefing session. During the debriefing, participants were asked a group several additional open-ended questions regarding their experience during the webinar and were asked to enter their responses into the chat. Table 13 outlines the debriefing protocol used to obtain the additional questions as well as reveal the true intent of the study.

Table 13

Study 2 Debriefing Protocol

Debriefing Question Numbers	Debriefing Statements
Question 1	Earlier in this session you were told that you would be joining a four-person group later in the session. However, I am letting you know now that you will not actually be joining a group. In fact, the experiment will be ending now. Because of this change, we are wondering if you have any ideas why we might be ending the session now and not asking you to join a group after all. Please type your answer into the Q&A. If you really don't know why we're ending now, just type in a zero.
Question 2	Sometimes in psychology studies, things are not always what they seem. That is, sometimes there may be more to the study than meets the eye. Did it ever cross your mind that there may be more going on here than what you were told? And, if so, what do you think was going on? Please type your answers into the Q&A. If it didn't cross your mind that anything more was going on, please type in a zero.
True Intent of the Study Statement	The project was designed to examine how STEM students respond to witnessing a group project team when the team exhibits respectful or disrespectful behavior. Disrespectful behavior in this context refers to subtle behaviors that may appear to discount or question women's ability in science or engineering. The video you watched previously showed a team enacting either respectful or disrespectful behavior, these are the two conditions of the experiment. We are testing whether viewing a team enacting one type of behavior or the other might influence people's performance and feelings about joining a team. In order to create testing groups that enacted different types of behaviors, the group members you saw were actually actors hired by the experimenters to enact the specific types of behaviors we were interested in.
Question 3	Okay, now that you know the whole story, did any of that occur to you during the experiment? Please answer "1" for yes or "0" for no in the Q&A.
Question 4	If you answered 1 for yes, do you think that this caused you to respond differently than if that had not occurred to you? Please answer 1 for Yes it made me respond differently, 0 for No I would have responded the same way.
Question 5	Now that you know the details about this experiment and about the two conditions, one shown a video of disrespectful behavior and one a video of respectful behavior, which condition do you think you were in? Please enter 1 for "disrespectful" or 0 for "respectful" into the Q&A.

The researchers also clarified to the participants that the study was designed this way in an attempt to obtain their natural reactions related to joining a group. The session was concluded by informing the participants of their rights, how to contact the research team, and how to opt out of the study. They were also informed that they would receive a $20 Amazon digital gift card via their university email account within a week.

Data Analysis

A regression analysis was performed for each outcome (spatial ability test performance/persistence, persistence in the field, and enthusiasm for working in a mixed-gender team), that regressed each outcome variable on video condition, participant gender, recognition of subtle gender bias as gender stereotyping, and their interaction terms. Recognition of bias was assessed in the same three ways as in study Closed-ended, Open-ended dichotomous score; and Open-ended continuous score.

The study used a 2(video condition: bias/control) x 2(attribution to stereotyping: high/low) x 2(gender: man/woman) between-subjects design. Measures included recognition of subtle gender bias as gender stereotyping (close-ended and open-ended assessments), spatial ability test performance and persistence, persistence in the field and enthusiasm for working in a mixed-gender team. Covariates included were Sexism Sensitivity, Negative Emotionality, Grit, and Mental Toughness.

Results

Study 2 Participant Recognition of Subtle Bias Events

Utilizing the same coding protocol outlined in Study 1, the open-ended coding resulted in 90 women and 97 men who witnessed the bias condition video. Table 14 outlines the breakdown of detection characteristics of the participants based on the five subtle bias events depicted in the video. Both genders were categorized based upon 1)

no recognition of the bias event, 2) recognition of the event, but didn't identify it as a bias interaction, and 3) recognition of the event and identified it as a bias interaction.

Table 14

Study 2 Numbers and Percentages of Participants in the Bias Condition Who Recognized and Labeled Bias Events by Gender

Event	Men			Women		
	No Recognition *n (%)*	Recognized, no bias *n (%)*	Recognized, bias *n (%)*	No Recognition *n (%)*	Recognized, no bias *n (%)*	Recognized, bias *n (%)*
1: note-taking	94 (97%)	1 (1%)	2 (2%)	80 (89%)	4 (4%)	6 (7%)
2: hepeat	78 (80%)	10 (10%)	9 (9%)	52 (58%)	14 (16%)	24 (27%)
3: interrupt/ talking over	47 (48%)	32 (33%)	18 (19%)	25 (28%)	22 (24%)	43 (48%)
4: questioning competence	88 (91%)	3 (3%)	6 (6%)	70 (78%)	6 (7%)	14 (16%)
5: mansplain	68 (70%)	7 (7%)	22 (23%)	60 (67%)	8 (9%)	22 (24%)
Overall: at least 1 event	16 (16%)	37 (38%)	44 (45%)	5 (6%)	24 (27%)	61 (68%)

Note: Men in bias condition (n=97) and Women in the bias condition (n=90).

Overall, the men in this study were least successful at recognizing bias in the note-taking (2 participants) and questioning competence (6 participants) events. They had the most success recognizing bias in the mansplain (22 participants) and interrupt/talking over (18 participants) events. Similarly, the women were least successful at recognizing the same bias events as the men, note-taking (6 participants) and questioning competence (14 participants), but had higher recognition compared to the men. While the women had the most success at recognizing the interrupt/talking over (43 participants) and hepeat (24 participants) events. Comparably, 45 percent of the men detected at least one bias event, while 68 percent of the women detected at

least one bias event. Unlike Study 1, there were no instances where the women had a higher percentage of “no recognition” than the men for any of the subtle bias events.

An analysis of open-ended bias recognition (dichotomous score) yielded a main effect of condition and a condition by gender interaction. Because the score is dichotomous, mean values reveal the percentage of women and men who recognized bias in each condition (see Table 15).

Table 15

Open-Ended Bias Recognition (dichotomous score) for Gender and Condition

	Control	Bias
Women	10%	68%
Men	7%	45%

Open-ended bias recognition (dichotomous score) was highly correlated with closed-ended bias recognition. As in Study 1, we also noted that a small percentage of both women and men detected bias interactions in the control video for Study 2.

Regressions

Spatial Ability Performance

Results of the regression analyses for spatial ability performance (overall M = 4.68*,* SD = 1.52) revealed significant main effects of Sexism Sensitivity (B = -.17, t = -2.01, p = .045) and Grit (B = -.32, t = -2.0, p = .047). Thus, Sexism Sensitivity and Grit showed a negative association with spatial ability performance for all participants regardless of gender or condition. There were no interaction effects detected. See Table 16 for detailed regression analyses.

Table 16

Regression Results for Spatial Ability Performance

Model	Variable	Unstandardized B	Coefficients SE B	β	*t*	*p*
1	Sexism Sen.	-.129	.065	-.116	-1.964	.050
	Neg. Emotionality	.033	.086	.029	.385	.701
	Grit	-.327	.156	-.119	-2.099	.037
	Mental Toughness	.236	.200	.085	1.181	.238
2	Sexism Sen.	-.173	.086	-.155	-2.008	.045
	Neg. Emotionality	.038	.088	.033	.431	.667
	Grit	-.318	.159	-.116	-1.996	.047
	Mental Toughness	.227	.205	.081	1.106	.269
	Gender	-.082	.342	-.027	-.242	.809
	Condition	-.256	.274	-.085	-.935	.351
	Closed-Ended Bias	.154	.106	.210	1.453	.147
	ConditionxGender	.149	.414	.042	.360	.719
	ConditionXClosed Bias	-.351	.275	-.159	-1.277	.202
	GenderXClosed Bias	-.334	.326	-.151	-1.024	.306
	ConditionxGenderXClosed Bias	.433	.416	.145	1.039	.299

Note: *N* =370. Results of the regression analyses for spatial ability revealed significant negative associations of Sexism Sensitivity and Grit. p = <.001.

Spatial Ability Persistence on Test

Results of the regression analyses for spatial ability persistence (overall M = 4.35*, SD* = 0.61) revealed a significant main effect of gender (B = .66, t = 2.39, p = .017) revealing an association between gender and spatial ability persistence, such that when all covariates were accounted for, women demonstrated higher spatial ability persistence. Specifically, women asked for more “additional” questions on the spatial ability test than men. There were no interaction effects detected. See Table 17 for detailed regression analyses.

Table 17

Regression Results for Spatial Ability Persistence on Test

Model	Variable	Unstandardized B	Coefficients SE B	β	*t*	*p*
1	Sexism Sen.	.040	.054	.045	.747	.455
	Neg. Emotionality	-.014	.070	-.015	-.199	.842
	Grit	.059	.128	.026	.457	.648
	Mental Toughness	.103	.165	.045	.625	.533
2	Sexism Sen.	-.096	.070	-.107	-1.383	.168
	Neg. Emotionality	.012	.071	.013	.166	.868
	Grit	.050	.129	.022	.386	.700
	Mental Toughness	.141	.166	.062	.847	.398
	Gender	.661	.277	.269	2.389	.017
	Condition	-.237	.222	-.097	-1.066	.287
	Closed-Ended Bias	.080	.086	.133	.924	.356
	ConditionxGender	-.274	.336	-.096	-.816	.415
	ConditionXClosed Bias	-.124	.223	-.070	-.558	.577
	GenderXClosed Bias	.258	.264	.144	.976	.330
	ConditionxGenderXClosed Bias	-.202	.337	-.083	-.600	.549

Note: *N* =370. Results of the regression analyses for spatial ability persistence revealed a significant main effect of gender. *p* = <.001.

Persistence in the Field

Results of the regression analyses for persistence in the field (overall *M* = 4.71, *SD* = 0.60) revealed significant main effects of Mental Toughness (*B* = .16, *t* = 2.02, *p* = .044) and Grit (*B* = .220, *t* = 3.66, *p* = <.001). Thus, Mental Toughness and Grit showed a positive association with persistence in the field for all participants regardless of gender or condition. There were no interaction effects detected. See Table 18 for detailed regression analyses.

Table 18

Regression Results for Persistence in the Field

Model	Variable	Unstandardized B	Coefficients SE B	β	*t*	*p*
1	Sexism Sen.	.014	.025	.032	.563	.574
	Neg. Emotionality	-.052	.032	-.117	-1.624	.105
	Grit	.205	.059	.188	3.480	<.001
	Mental Toughness	.154	.076	.140	2.044	.042
2	Sexism Sen.	.000	.032	.001	.010	.992
	Neg. Emotionality	-.046	.033	-.103	-1.395	.164
	Grit	.220	.060	.202	3.661	<.001
	Mental Toughness	.156	.077	.141	2.022	.044
	Gender	.102	.129	.085	.795	.427
	Condition	.018	.103	.015	.179	.858
	Closed-Ended Bias	.001	.040	.004	.030	.976
	ConditionxGender	-.238	.156	-.171	-1.528	.127
	ConditionXClosed Bias	-.072	.103	-.083	-.697	.486
	GenderXClosed Bias	.080	.123	.092	.655	.513
	ConditionxGenderXClosed Bias	.087	.157	.074	.557	.578

Note: *N* =370. Results of the regression analyses for persistence in the field revealed significant main effects of Mental Toughness and Grit. *p* = <.001.

Enthusiasm for Mixed-Gendered Teamwork

Results of the regression analysis for enthusiasm for mixed-gender teamwork (overall *M* = 4.09, *SD* = 1.51) revealed a significant main effect of condition, such that participants reported greater enthusiasm for mixed-gender teamwork in the control (*M* = 4.95) than the bias condition (*M* = 3.21), (*B* = -.62, *t* = -3.17, *p* = .002). There was also a significant main effect of close-ended bias recognition (*B* = -.36, *t* = 4.72, *p* = <.001), such that the more participants recognized bias, the less enthusiasm they had for mixed-gender teamwork. A significant three-way interaction gender x condition x close-ended

recognition of bias emerged (*B* = -.67, *t* = -2.27, *p* = .024). See Table 19 for detailed regression analyses.

Table 19

Regression Results for Enthusiasm for Mixed-Gendered Teamwork

Model	Variable	Unstandardized B	Coefficients SE B	β	*t*	*p*
1	Sexism Sen.	-.082	.066	-.074	-1.251	.212
	Neg. Emotionality	-.028	.086	-.025	-.327	.744
	Grit	-.057	.157	-.021	-.366	.715
	Mental Toughness	.203	.201	.073	1.010	.313
2	Sexism Sen.	.065	.061	.058	1.056	.292
	Neg. Emotionality	-.009	.062	-.008	-.149	.882
	Grit	-.034	.114	-.012	-.301	.764
	Mental Toughness	.148	.146	.053	1.014	.311
	Gender	.254	.244	.084	1.044	.297
	Condition	-.619	.196	-.206	-3.167	.002
	Closed-Ended Bias	-.358	.076	-.488	-4.721	<.001
	ConditionxGender	-.388	.296	-.111	-1.314	.190
	ConditionXClosed Bias	.168	.196	.077	.857	.392
	GenderXClosed Bias	.179	.233	.081	.767	.443
	ConditionxGenderXClosed Bias	-.673	.297	-.226	-2.266	.024

Note: *N* =370. Results of the regression analysis for enthusiasm for mixed-gender teamwork revealed a significant main effect of condition, a significant main effect of close-ended bias recognition, and a significant three-way interaction of gender by condition by close-ended recognition. *p* < .001.

For all participants, when they recognized bias in the video, they reported lower enthusiasm for mixed-gender teamwork compared to when they failed to recognize gender bias in the video. When they did not recognize bias, they reported higher levels of enthusiasm. Table 20 provides the results of this analysis for all participants, men participants, and women participants. For men alone, this interaction is not significant, with simple main effects of condition and recognition, such that men in the bias condition

(regardless of recognition) exhibited lower enthusiasm, as did men who recognized bias in either condition. However, when women are exposed to and recognize bias, they become less enthusiastic about participating with the team they observed. However, if they lack recognition, their enthusiasm is less negatively affected. This is particularly harmful to women as 68% of them recognized bias in the bias condition, whereas only 45% of men did.

Table 20

Enthusiasm by Video Condition and Bias Recognition

Men	Control	Bias
Low Recognition (-1)	5.23	4.43
High Recognition (+1)	3.80	3.29
Women		
Low Recognition (-1)	5.25	4.63
High Recognition (+1)	4.18	2.59

Note: *N* =370. For all participants, when they recognized bias in the video, they reported lower enthusiasm for the team. However, when women are exposed to and recognize bias, they become less enthusiastic about participating with the team they observed.

Discussion

We hypothesized that women in this study in the bias condition (witness subtle gender bias events) would experience stereotype threat and perform worse on the spatial ability test than men in the bias condition. We also hypothesized that recognition might play a role in their performance, perhaps protecting them from stereotype threat. However, there were no significant interaction effects related to persistence in the field nor performance, suggesting that threat was not induced by the bias condition. This could be due to an ineffective cover story such that participants didn't perceive the test

as diagnostic, or the experimental context of subtle gender bias wasn't an influential enough prompt to trigger stereotype threat.

Based on the findings of this study, all participants were less enthusiastic about working with the team in the bias condition. However, for women this enthusiasm was directly linked to recognition in the bias condition. Thus, in conjunction with Study 1, when bias is present, recognition caused people to temper explicit beliefs, however, women still remained hesitant to join the team, potentially causing them to be less engaged in the environment. Vossoughi and colleagues (2024, in review) found that when women witness bias in comparison to not witnessing bias, they also had a comparably low enthusiasm for group work. This work supports the findings of this study.

Schmitt and colleagues (2022) found that women's well-being was impacted in pervasive gender discrimination contexts when compared to men. They also found that women make negative evaluations in pervasive sexism conditions versus when they perceived that the instances of sexism were isolated instances. In other words, when women experience a repetitive sexist environment as reflected in they are left with negative impressions of the existing condition. These impressions also result in emotional implications. In alignment with the literature regarding the four pathways of microaggressive stress (Sue, 2010), it is worth noting that instead of performance or persistence, women had an emotional response (decreased enthusiasm) related to the team interactions they observed. Thus, a lack of enthusiasm within a STEM educational environment can have a range of emotional impacts such as not feeling connected to the team, disappointment by the team repetitive sexist behavior, or even exhaustion through a loss on interest in engaging with the team.

Measures of persistence showed that Mental Toughness and Grit were significantly correlated with persistence in the field measure, while Grit was negatively correlated with the spatial ability test scores. This difference may be due to differences in how Mental Toughness and Grit affect individuals. Mental Toughness has been shown to affect immediate outcomes, whereas Grit is more relevant to longer term outcomes. They both aid individuals in creating capacity for sustained effort. Dr. Angela Duckworth (2007) stated that “Grit is about working on something you care about so much that you’re willing to stay loyal to it.” As it relates to this study, persistence in the field leverages both present and future persistence. Alternatively, when participants were in a real-time performance situation (spatial ability test) they were less gritty. Stated a different way, the presence of Grit decreased as performance increase, perhaps because students were in a present moment performance condition. In other words, because the test was a measure of performance and not persistence is the reason why there was a negative correlation to Grit. This could also be why Mental Toughness was not correlated to the spatial ability test.

Limitations

This study was conducted real-time in a virtual environment, so there were some believability issues related to the teams observed during the videos. A small percentage of participants (4%) mentioned not believing the video, or that the people were actors. This is a challenging manipulation to execute as some participants may actively look for the deception that they were notified about in the consent form. Additionally, perhaps the online nature of the study made it difficult for participants to believe that they were actually going to join a team.

The finding that this study did not produce significant gender differences in test performance, even when bias was present was a limitation of this this study. Research regarding gender difference related to spatial ability tasks has been up for debate. Maccoby and Jacklin (1974) were some of the early researchers to conclude that men had better spatial ability than women. The spatial ability test was leveraged with the notion there are stereotypes related to gender differences on mental rotation tasks, especially with bias is present in the environment. Thus, previous research produced effective results utilizing spatial ability tests to trigger stereotype threat. It is worth noting that at Michigan Tech, first-year engineering students who don't meet the baseline on their spatial visualization placement test complete a 1-credit remediation course. The course is designed to develop 3-D spatial visualization skills, it possible that some participants in the study were enrolled into this course which may have had an impact on our findings. With these considerations in mind, replicating this study at an alternative institution to determine if there are inter-institutional differences should be explored. Additionally, exploring a more effective manipulation in bringing about stereotype threat utilizing the spatial ability instrument can be an alternative approach to this limitation.

Due to difficulties in recruitment, this study was made available to wider range of STEM students instead of majors with 30% or fewer women representation in comparison to Study 1. This resulted in more first-year student involvement in this study which could have influenced the results as first year students are typically less experienced in team and project work and are newer to the STEM higher education environment (in which women are under-represented) in comparison to third- and fourth-year students.

Finally, as with Study 1, this study utilized a binary view of gender, and did not present any findings regarding people who identify otherwise (i.e. non-binary, gender fluid, etc.). Future research should broaden the range of social identity groups included, to increase understanding of how witnessing and recognizing bias affects individuals more broadly.

Future Work

Additional analysis of the open-ended responses and debrief questions could build upon the results of Studies 1 and 2 as it relates participants in both studies detecting low levels of bias in the control condition. For example, during the debrief of this study we asked the participants whether they believed that they were in the bias or control condition. It would be worthwhile to explore whether they identified the correct condition to determine if the results would be consistent with bias detection results in the control condition as well as determine if there are any trends based on gender, major, or year in college. These findings could also aid in designing future studies where participants are able to elaborate more about what they're seeing utilizing quantitative research methods.

An unanticipated finding of this study was that witnessing subtle gender bias events did not trigger stereotype threat in the women participants. Examining the linkage between subtle gender bias and stereotype threat is worthy of future exploration as it could aid in our understanding of the various types of triggers that might influence women's performance in a STEM educational environment. For example, having two conditions, one is which gender is more salient prior to the test, and the other condition being subtle bias. Subsequently exploring if women attribute their performance on the test in differing ways.

Also, if we were to replicate this study in-person we could consider making bias more immediate and relevant to the participants. Kawakami and colleagues (2009) conducted a study on racial bias utilizing confederates to incite moderate slurs. They found that participant expressed feeling emotional distress because of the racist comment, however there were differences in predicted responses to bias compared to the participant's actual reactions. Elements of their study could be replicated to determine whether confederate gender slurs made prior to the spatial ability test would significantly impact performance, persistence, and enthusiasm.

In addition to the women, men in this study expressed less enthusiasm to work with the team they were exposed to in the bias condition. Although they are not recognizing bias, this finding speaks to the men's ability to detect interactions within the team that are not favorable and/or does not inspire them to join. Thus, it is worth gaining an understanding what men are seeing (cues) as they view the bias events, how they feel about what they are viewing, and how they interpret their observations (mental model).

Conclusions

This study was designed to advance our understanding of STEM women's performance and persistence as compared to men when they recognize subtle gender bias events. Although performance on the spatial ability test did not support the hypothesis, when both men and women witnessed subtle gender bias, their enthusiasm to work in teams when they detect the presence of bias was affected.

This examination of the effects of recognition of subtle gender bias on outcomes related to performance and persistence constitutes a unique approach to guide a potentially transformative outcomes of addressing equity in the field for all individuals.

Study 1 findings reinforced that bias recognition is a significant contributor to decreasing explicit endorsement of gender stereotypes. Thus, because fewer men in this study recognized bias (less than half – 45%), the responsibility to act on reduced explicit stereotype endorsement falls to a smaller group of majority individuals. Therefore, it is important to understand the mechanisms by which majority men might recognize (or not recognize) subtle gender bias events. Building on this new research provides an opportunity to explore subtleties in the identification and attribution of subtle bias as seen and interpreted by the witness. For instance, if a witness attributes a bias event to rudeness, the witness may experience differential outcomes. This information can be used to further inform the approach taken in Study 3 (see Chapter 4) to explore the cues, emotions, and metal models associated with recognition.

Chapter 4 (Study 3) ~ Subtle Bias Detection by Majority Population

Subtle gender bias can be ambiguous and difficult to identify. Study 1 assessed the influence of witnessing subtle gender bias on stereotype endorsement, revealing that witnessing subtle gender bias can increase explicit endorsement of gender stereotypic beliefs for both men and women. However, those who recognize bias report lower explicit endorsement of STEM stereotypes, at a level comparable to not witnessing bias. Thus, recognition of bias may serve the role of breaking a recursive process that allows the propagation of STEM gender stereotypes (Slade et al., 2022). Study 2 assessed these same effects on performance and persistence, finding that when women detected gender bias in the environment, they were less enthused about engagement with a similar team, even though their performance on a spatial ability test was not negatively impacted. Results from Studies 1 and 2 indicated that the men in both studies were unable to detect bias events at the same rate when compared to women. In consideration of these results, the aim of Study 3 was to obtain a deeper understanding of the types of subtle gender bias events that individuals from a majority population recognize, and how they interpret these events when they observe them. Results from this study can aid in identifying evidence-based solutions to equip witnesses with strategies to circumvent the problematic behaviors of subtle gender bias.

Because STEM professions are historically dominated by white cis-gendered men, gaining insight on their observations can aid in the development of strategies to identify and address bias behaviors that aren't easily detected. By asking participants about their observations of subtle bias events we capture the complexities and nuances of their interpretations that are not readily evident in quantitative approaches. A qualitative approach facilitates participants in sharing their individual subjective

perspectives, while affording the researchers an opportunity to better understand a comprehensive picture of each participant's mental models. Outcomes of this research complement the quantitative data of the previous studies and enhance the accuracy and completeness of the research findings in an effort to understand bias recognition, associated cues to recognition and non-recognition, and how these events are interpreted by individuals who hold power in STEM.

Research Questions

The aim of this study is to address the following research questions:

R1: What types of subtle gender biases do majority group members (e.g., white men who usually aren't the targets of STEM stereotypes) detect when they witness them in a student engineering team context and how are they interpreting what they observe?

Sub-Questions:

1. What cues (verbal & non-verbal) are participants paying attention to?
2. How do these interactions make the participants feel after viewing them?
3. How do they make sense from viewing the interaction?

This research question and its sub-questions are designed to explore the nuanced sense-making of majority individuals when witnessing subtle bias in collaborative team environments in a STEM educational setting. The deep understanding of the mental models employed by men from majority populations to detect or not detect subtle bias amongst peers is essential to developing strategies to mitigate the detrimental effects and well-being of those negatively affected by chronic exposure to subtle bias.

Background

This qualitative phenomenological study consisted of semi-structured interviews modeled after the work of Haynes-Baratz and colleagues (2022) in which they examined the effect of gendered MA among faculty in the context of the academic workplace. Their research was motivated by an NSF research project to develop tools to detect MA while developing training programs for bystanders. They conducted face-to-face semi-structured interviews with 12 cisgendered faculty members (8 men and 4 women: 10 were STEM professors). Faculty were asked to discuss instances of MA they've witnessed and elaborate on their reactions and responses. In their discussions, seven participants acknowledged that they made attempts to help the targets. The participants also addressed several instances where they didn't take any action in the situation, resulting in self-correcting strategies or being apologetic to their targeted colleagues of these MA. Results of the research project identified several key findings that will aid this current study, and the methods employed can be replicated to some degree herein.

First, participants discussed that personal experiences in cultures different from their own aided them in having an awareness of how subtle bias is problematic. One participant specifically mentioned previous training in empathy had aided in their ability to detect subtle bias. Another participant attributed their awareness to living in another country and the realization of gender inequities in their home country. Four men in the study specifically identified that their mothers, daughters and/or female partners previously experienced bias, causing them to be able to identify bias when they witnessed it. Furthermore, all of the women in the study noted that aspects of their personal experiences with MA in their own career and their social identity were among the reasons they were able to detect subtle bias as witnesses.

Second, participants indicated that ignorance in not knowing the correct way to respond hindered them from intervening when they witnessed subtle bias. They also expressed concern related to the effectiveness of the intervention if they had responded to the biased interaction. Commentary such as picking their battles, lack of institutional power, confronting the bias was not worth it, doing more harm than good, and concerns of retaliation, were some of the explanations for inaction.

Third, participants indicated that looking to other witnesses to take action prevented them from acting. They were unsure if they should respond due to the ambiguous nature of subtle bias, leaving them with questions of uncertainty and the looming possibility that they could be wrong if they were to respond.

Haynes-Baratz and colleagues (2022) provided insight to how nebulous it can be when one witnesses subtle bias in an academic context, often resulting in power dynamics that prevent and inhibit witnesses from intervening or taking action against bias behavior. Consistent with their approach, my study also consisted of semi-structured interviews, but specifically with cis-gendered white men. Instead of directly inquiring about MA observed, participants in my study were asked to describe what they saw as subtle gender bias events as they were happening. They were not informed that they were specifically looking for bias events. Consistent with the methodological approach of Haynes-Baratz and colleagues (2022), questions were designed to 1) gather information about what participants saw (or did not see) after witnessing subtle bias events, 2) elicit their observations, and 3) leveraging the critical incident technique to explore participants' mental model as they observed the interactions of the team. I also leveraged similar interview questions related to 1) contributing attributes of the bystanders, perpetrators, and victims of bias events, 2) factors and cues that caused

various reactions to bias events, and 3) recommended actions for future team interactions of this nature. Finally, as with Haynes-Baratz and colleagues (2022), I also leveraged several coders and an in vivo coding approach to refine the coding scheme of this study.

Methods

Study Design

Two methodological approaches are utilized during this study to inform the interview protocol, Critical Incident Technique (CIT) and Interpretive Phenomenological Analysis (IPA). CIT (Flanagan, 1954) is a systematic approach to obtain perspectives from a wide variety of participants through one of the most accessible human discourse avenues, the narrative. It is useful in the early stages of understanding a phenomenon and it is an inductive way of categorizing incidents and synthesizing various clusters in order to interpret results. CIT is frequently used to collect data on observations previously made, however, in this study, witnesses discussed their observations and articulated an evaluation of their observations in real-time. An important advantage of this approach is the emphasis on events that are directly observed by the participants. Furthermore, this approach empowers the participant to discuss what was most relevant to them as a witness (bystander) instead of fitting their interpretations into themes determined in advance by the researchers.

IPA is rooted in exploring how individuals make sense of their social interactions and personal experiences. Phenomenology is the study of understanding one's lived experiences (Creswell, 2007). Smith and colleagues (2009) introduced IPA as a theoretically based qualitative approach to understanding a person's connection to their speech, thinking, and emotional state. IPA has been used in previous studies of MA

research such as understanding social class MA (Cook & O'Hara, 2019), black student experiences at public and private predominantly white institutions (PWI) (Williams et al., 2020), and verbal and emotional abuse toward aging women (Kozina-Evanoski, 2020). Osborn and Smith (2006) describe IPA as a recommended methodology when research topics are multidimensional and related to identity. At its core, IPA is a suitable approach for a researcher whose aim is to understand how a person perceives a situation that they are experiencing, especially when their experiences are complex (e.g. subtle bias) or novel in nature. During IPA, sense-making is happening by both the participant and the researcher, with cognition as its central analytic priority. IPA projects are commonly framed broadly and openly, allowing both the participant and researcher to explore the sense-making process progressively. In alignment with the intentionality of this study, the IPA methodology approach highlights the importance of participant selection such that participants are selected to aid researchers in accessing a particular perspective on the phenomenon (i.e. subtle gender bias) being studied (Smith et al., 2009).

In compliance with IRB guidelines, participants were informed that their participation in this study was voluntary, and they could withdraw their participation at any time without penalty by simply notifying us via email; at which point all records of their participation would be destroyed. However, we did not have any participants withdraw from the study. All participants were anonymized by assigning them a participant ID number, and their name in the Zoom meeting was changed to display their participant ID number (instead of their name) to maintain anonymity. Participants were addressed by their ID number throughout the duration of the interview.

IRB approved deception was utilized during this study and participants were recruited under the pretense that as leaders they are observing the team dynamics of a

student project team in search of positive and negative interactions between the 4-member team. However, the purpose of this study was to obtain qualitative data on the ways that STEM students from a majority population notice and interpret subtle gender bias events while observing a collaborative team interaction via a recorded video, participants were debriefed as to the real purpose of the study at the end of the interview.

Participants

A total of 19 participants were recruited from Michigan Tech, a mid-sized predominately white institution (PWI) in Midwest United States. The institution's student population is approximately two-thirds men, and over seventy percent of the students are pursuing a STEM major. All participants identified their race as white (majority population) and were cis-gendered men. Ethnically, 18 were not Hispanic/Latino and 1 participant was Hispanic/Latino. 17 participants were undergraduates (8 juniors and 9 seniors) and 2 were recent graduates from the institution. All were STEM majors, with most participants majoring in mechanical engineering, but also including participants majoring in data science, computer networking and systems administration, psychology, civil & geospatial engineering, and computer & electrical engineering. Participants' ages ranged from 20 to 24 years (M = 21.7, SD = 0.91). Participants were recruited via targeted email, classroom announcements, flyers, and word of mouth. On average, interviews lasted for 1 hour and 11 minutes (shortest duration 50 minutes and longest duration 2 hours and 25 minutes). Comparable with the previously mentioned study on gendered MA qualitative bias (Haynes-Baratz et al., 2022), the goal was to recruit a minimum of 8-10 participants, 19 were recruited for this study, as this was when theoretical saturation was reached (Morse, 1995).

Participant Recruitment

Participants were invited to complete an online demographic and pre-screening questionnaire to determine eligibility for the study. Eligibility criteria included self-identified U.S. citizen men of white race studying in STEM majors. Additionally, I targeted men who were at least in their junior level of their studies in an effort to engage participants with some level of collaboration, team, or project experience. Participants were told that the aim of the research is to observe a video of a working project team and provide feedback regarding the observed team interactions. Qualified participants were sent a confirmation email to explain the goals of the study and confirm a Zoom interview time. They also received a link to complete an online survey consisting of 1) a consent form to confirm their willingness to participate in the study and video recording, and 2) a preliminary survey consisting of the QACE empathy questionnaire. Participants also received a calendar invitation which included their Zoom time as well as a courtesy text reminder 10 minutes prior to the start time of their interview if they opted-in for the reminder. Upon completion of the interview participants chose to receive either 1) a $20 digital Amazon gift card delivered to their Michigan Tech email address, or 2) course credit in their Intro to Psychology Course via Michigan Tech's online Psychology Subject Pool System (SONA).

Materials

Questionnaire of Cognitive and Affective Empathy (QCAE)

A portion of the QCAE (Reniers et al., 2011) was used to measure a participant's cognitive empathy. Participants responded to 19 items which constituted the cognitive empathy scale. The scale is made up of two subscales of the QCAE, perspective taking and online simulation. Perspective taking involves intuitively putting oneself in another

person's shoes to see things from his or her perspective, an example of a question is "I can easily work out what another person might want to talk about." Online simulation encompasses an effortful attempt to put oneself in another person's position by imagining what that person is feeling. Online simulation is likely to be used for future intentions. An example question is "Before criticizing somebody, I try to imagine how I would feel if I was in their place." Items are rated on level of agreement using a 1-4 Likert scale ranging from 1 "strongly disagree" to 4 "strongly agree". $\alpha = .87$.

Interviewer Selection

According to research from Devotta et al. (2016), engaging participants with near-peer researchers and similar lived experiences (in this context, STEM academic and similar educational experience) establishes rapport and facilitates a level of comfort in the interview process resulting in meaningful and rich data from participants. My age (49), race (African-American), gender (woman), and role (staff member at the university) therefore may serve as a barrier to building rapport and eliciting meaningful data from my target audience (white, cis-gender male). Thus, I hired a cis-gendered white male research assistant to conduct the interviews. He recently completed his undergraduate degree in the mechanical engineering program at Michigan Tech. This approach aimed to minimize bias as well as prevent any forms of directive or influential response from participants of the study. During the interview, the research assistant was the only interviewer the participants saw "on-screen" via Zoom. I was present for all of the interviews, but remained off-camera and my identity was not disclosed. The participants were told that another researcher was present to ensure that consistency was maintained across each interview but would remain off-camera. During each individual's interview I had the opportunity to actively listen, make notes of when my own biases

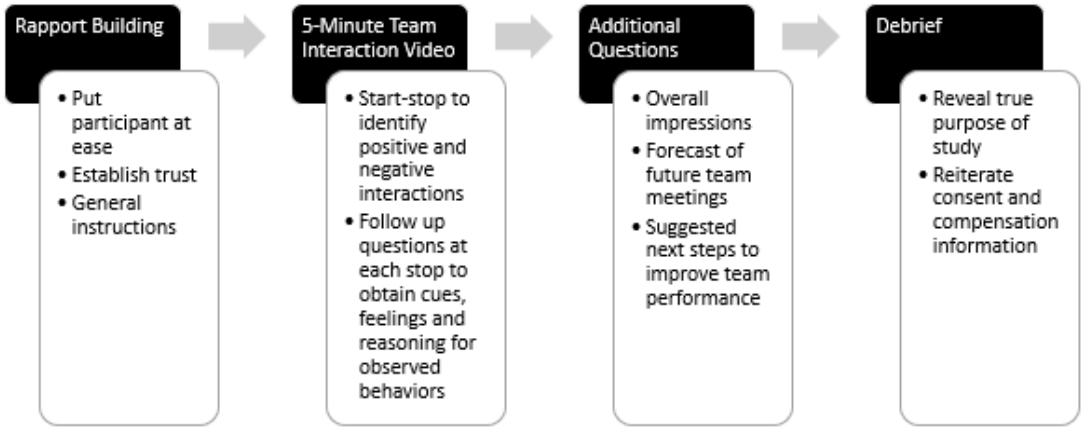
arose as a result of the participant's observations (IPA methodology), as well as send text follow-up/clarifying questions to the research assistant to ask the participants in real-time during the semi-structured interview.The research assistant was familiar with conducting research in other capacities during his undergraduate studies, however human subjects research and protocol was new to him. Thus, he was trained in this form of qualitative research methodology. He read several articles related to gendered MA and subtle gender bias research to ensure he had a contextual understanding of this line of research. We also discussed our personal experiences with MA and biases and their implications as a baseline. He was provided with reports documenting the design, data collection and data analyses of Studies 1 and 2 as a reference. He also completed the required CITI Program training on Human Subjects Research. We also had extensive discussions on the importance of maintaining neutrality while conducting the interviews. He was given an interview script which included the step-by-step interview protocol to review and rehearse. Finally, we conducted several practice Zoom interviews one with a colleague from our research team (an expert in subtle bias research) as well as one with a recent Michigan Tech graduate who was unfamiliar with the purpose of the study, but well versed in team dynamics and project work. Both individuals offered feedback which served to improve the interview experience for participants, while also fine-tuning the technical aspects of the Zoom video conferencing technology.

Interview Procedure

The interview included four main sections: rapport building, the start/stop observation of the 5-minute team interaction video, a series of additional questions and a debrief (see Figure 8).

Figure 8

Study 3 Interview Procedure Diagram



Rapport Building

At the beginning of the interview, the research assistant interviewer took time to build rapport with each participant. He gave a brief personal introduction which included his major, hometown, career pursuits and what he likes to do in his spare time (i.e., cooking, biking and research). He also invited the participants to share the same about themselves. This important first step is commonplace in qualitative research to ensure that a trustful relationship is established between participants and the interviewer. It serves to create participant cooperation and empowerment, validation, and vulnerability between the participant and interviewer (Råheim et al., 2016). Additionally, rapport building afforded the interviewer to obtain candid and honest observations and interpretations from participants, while allowing the opportunity to delve deeper and elaborate on various questions throughout the interview. This approach provided richer and more nuanced data to aid in the integrity and reliability of the research.

5-minute Team Video Interaction

Once rapport building was completed participants were oriented with how to navigate Zoom functions, then the interviewer informed the participants that the aim of the study is to observe a working team interaction and provide feedback on their team dynamics. Participants were informed that they would watch a 5-minute video (the bias video utilized in Studies 1 and 2) of a project team interaction between four students (two men and two women) who are meeting to work on their project. Participants were instructed that as they were watching the video they should request the interviewer to stop the video upon every event when they notice any positive or negative team interactions. Once the video was paused, the interviewer asked the participants a series of questions (see Appendix C) to clarify whether the stop was deemed positive or negative, to explain why they stopped the video, and articulate what they observed.

Additional Questions

Upon the completion of the "start/stop" portion of the 5-minute video the interviewer asked additional questions related to the participant's overall impressions of the video, a forecast of behavior at future team meetings, and potential next steps to improve team performance. Upon completion of the second portion of the video the interviewer concluded the formal interview and began the debrief with the participants. During the debrief the participant was informed of the true goal of the study related to recognition of subtle gender bias. Each interview concluded with reiterating how participants would be compensated/credited for their time, how they could withdraw from the study, and how to contact the research team if they had additional questions.

Debrief

At the conclusion of the interview the Zoom recording was downloaded and stored in a password protected cloud-based repository. Additionally, the interviewer and I discussed our overall initial impressions of each interview and documented those notes. These debrief sessions aided us in determining when we were approaching and had reached saturation in the interviews.

Data Analysis

Transcription processes are labor-intensive, requiring careful attention to detail. As such, the process for this study involved a multi-pass transcription design, including a reading and listening strategy (outlined below) to ensure accuracy of the participant interview while leveraging qualitative coding techniques to interpret the interviews.

Pass 1: Although the Zoom software created an initial transcript, the transcripts contained several errors. To address these inconsistencies, two undergraduate research assistants (RA's) reviewed and corrected the first round of verbatim transcription edits. With the Zoom transcript in front of them, they listened to the video verbatim for accuracy and made corrections to the master transcript accordingly. In addition to corrections, the research assistants also highlighted each of the participant's stops in the text and noted them as positive or negative. Consequently, a master spreadsheet was created that identified each positive and negative stop with timestamps, how the participants characterized each of the 5 subtle bias events (positive or negative), and the participant's exact words (direct quotes) regarding their characterizations of the 5 subtle bias events.

Pass 2: This pass of the transcripts was made with two main priorities: accuracy and bracketing. I personally listened to and reviewed each of the interview transcriptions

for accuracy after the RA review. Minor edits were made and upon completion of my review, the master transcripts were finalized and ready for additional analysis.

The second priority during this pass was to incorporate the IPA practice of bracketing while listening and reviewing the transcripts, it is a process of confirming the results and research process. While it is not possible to be fully objective, bracketing deliberately requires the researcher to set aside any preconceived understandings of the phenomenon being studied both prior to and throughout the study's investigation (Carpenter, 2007). There are several approaches to bracketing such as analytical memos, bracketing interviews or reflexive journaling. For this study I used reflexivity which requires an honest evaluation of the researcher's own values and interests by way of a reflexive diary where internal perceptions, metacognitive thoughts, emotional responses, and feelings are documented. These strategies of self-reflection and self-awareness helped me to identify my areas of bias by "bracketing" them, as well as to "bracket" my previous knowledge in the subject area (Ahern, 1999). I reviewed and documented in my reflexive diary in real-time throughout the interviews as well as during that coding process to maintain an awareness of my areas of bias. I documented any new observations that arose, thus ensuring that the research findings are rooted in the participant's perspective and not my beliefs, values, or biases.

Pass 3: The third pass was an inductive coding pass of the transcripts using an in vivo approach. During this pass, the goal was to derive codes to condense and synthesize the interview transcripts in a way that facilitates the analysis process. I referred back to my three sub-questions to create a coding protocol (See Appendix D), highlighting the transcripts based on the key questions that were addressed during the interview, thus activating three key areas:

1. Cues (verbal/non-verbal and positive/negative) that participants observed throughout the interview.
2. How the interactions made them feel (positive/negative) as they observed them.
3. How each participant made sense (mental model) of what they observed. For example, why they believe individuals behaved the way that they did, and their overall impressions, justifications, rationalization, and/or assessment of the interactions they observed.

During this pass, another coder and I (one of my research advisors who was very familiar with my research as well as research related to subtle gender bias) utilized this coding scheme to separately code each of the interviews. We employed in vivo coding, a qualitative analysis approach which centers on the spoken words and phrases of the participants by heavily relying upon the participants to make meaning of their observations, feelings, and perspectives (Charmaz, 2014). This approach captured and preserved the participant's interpretations of what they observed by using their own words (direct quotes) based on their salient words that addressed the research questions (Saldaňa, 2015). This coding approach also provided trustworthiness and credibility to the overall analysis process, by identifying emergent themes across all of the participants while also capturing the unique individual perspective and contextual understanding of each participant. Each coder strived to refine and conceptualize the cues and interpretations into clusters that were relevant and aligned with the research questions of this study.

The two coders then met to interpretively converge their individual findings. Reconciliation was utilized during this pass to discuss the findings and reach a consensus related to each individual coding process. This pass of the data was

important to ensure that interpretations of the coding are not skewed by one individual's biases. We worked within a well-defined coding framework and utilized direct quotes from the participants. The coders did not take a quantitative approach to reliability, instead we heavily leveraged consensus through an in-depth discussion and adjudication of each participant's interview. This coding approach aligns with Harry et al. (2005) in which the goal is consensus and agreement through discussion and clarification. To codify our findings, we utilized sticky notes to write down how each participant articulated their observations (cues, feelings, and mental models) of each of the 5 events of subtle gender bias in the video. For each of the 5 events of bias, we categorized the cues and interpretations the participants made as a result of those cues.

Results

Participant Recognition of Subtle Bias Events

As mentioned previously, the video that participants viewed contained 5 events of subtle gender bias. Table 21 details how each individual participant characterized the 5 bias interactions. Within the table, "0" indicates no stopping for an event (positive or negative), "+" signifies a stop with a positive interpretation, "-" signifies a stop with a negative interpretation, "b" signifies a stop with a negative interpretation that includes an indication of bias, and "v" signifies a stop with a negative interpretation and victim blaming presented as the primary reason for the stop. Victim blaming occurs when someone assigns fault to individuals/groups who are targets of injustices. In the context of this research, it is a justification used to discredit the target of subtle gender biases when they have a response (cues) or speak out against the bias event (Johnson et al., 2021). Victim blaming was articulated by several participants for 2 of the 5 bias

interactions of the video: the first bias interaction (note-taking) and the fourth bias interaction (questioning competence).

Table 21

Study 3 Recognition of Bias Events by Participant

Participant	Events				
	1: note-taking	2: hepeat	3: interrupt/ talking over	4: questioning competence	5: mansplain
1	-	+	-	0	-
2	-	+	-	+	-
3	-	+	b	0	b
6	-	+	0	-	-
7	-	+	-	+	b
8	-	-	-	+	b
10	v	-	-	0	-
13	0	+	-	0	b
14	-	-	-	+	-
15	-	-	-	+	+
16	+	+	+	v	-
17	-	b	-	0	-
18	-	-	b	v	b
19	v	-	-	0	-
20	b	b	-	v	-
21	v	-	-	+	b
23	-	-	b	+	b
24	-	-	-	v	-
25	0	+	-	0	-

Note: *N* =19. “0” indicates no stopping for an event, “+” signifies a stop with a positive interpretation, “-” signifies a stop with a negative interpretation, “b” signifies a stop with a negative interpretation that includes an indication of bias, and “v” signifies a stop with a negative interpretation and victim blaming presented as the primary reason for the stop.

On average, participants identified 3 to 4 of the 5 bias scenes as negative, thus seeing the video as predominantly negative. However, the maximum number of events identified as bias by any individual participant was two of the five events (five participants); there were four participants who identified only one event of bias. Alternatively, 10 of the participants did not articulate recognizing any events of bias

during their video observations, although all recognized at least two events as negative. Thus, while viewed predominantly as negative, less than half of the participants identified the negative behaviors as related to bias. This is consistent with the results of Study 2, which was conducted at the same institution. In Study 2, 46% of white men recognized at least one event as bias. In this study, 47% (9 participants) detected at least one event as bias.

Taking another look at each incident, Table 22 provides a summary of the distribution of participant stops for each subtle bias event in the video.

Table 22

Study 3 Summary of Total Participant Stops and Characterizations by Event

Event	Did not stop video – no recognition *n*	Stopped video - positive *n*	Stopped video – negative *n*	Stopped video – negative & labeled as bias *n*
1: note-taking	2	1	15 (3V)	1
2: hepeat	0	8	9	2
3: interrupt/ talking over	1	1	14	3
4: questioning competence	7	7	5 (4V)	0
5: mansplain	0	1	11	7
Summary	**10**	**18**	**54**	**13**

Note: 3V and 4V represent the number of participants who presented victim blaming as the primary reason for the stop.

The first event, “note-taking” was primarily seen as a negative incident, however it was rarely characterized as bias by the participants. One participant described the interaction in this way, “Seems like he’s trying to get somebody else to take the notes instead of himself, he’s just kind of trying to put more responsibility on other people.” One factor that contributed to the negative stop was the behavior of one of the women

(Rachel) on the team. From the perspective of several of the participants, Rachel was hesitant, rolled her eyes, and had an unfavorable tone in her voice as she offered to take the notes. One participant described Rachel's response as "kind of a snarky remark to my understanding. She said sure, but not really too positive about it." Thus, the woman's response (verbal and non-verbal) contributed to this interaction being declared negative by participants.

The second event, "hepeat" had the highest number of positive stops by the participants (8). One participant described it as, "the interaction was constructive, and everyone was on the same page. Everyone's idea was building off each other, not attacking." Although many of the participants found this to be a positive interaction, more than half characterized it as negative, with two recognizing the event as bias.

The third event, "interrupt/talking over" was the event declared as negative most often, with 14 participants noting it as a negative interaction, and an additional 3 participants recognizing it as related to bias. One participant described it as:

> "Before she [Erika] could finish what she was saying, the other guy [Ethan] cut her off, saying that it could definitely shoot 300 feet. Then the 2 guys kept having their conversation, and the other individual [Erika] wasn't able to contribute to what they were saying, because they just weren't paying attention to her."

The fourth event, "questioning competence" was the only interaction for which none of the participants characterized it as bias. It was also the most missed interaction, with 7 participants not asking for a stop at all as they viewed this event. When this event was characterized as a positive interaction it was commonly characterized as a compliment. For example, one participant said, "He made a positive remark to her, he complimentarily said that she was smart, basically". As in the first event, Rachel's

response to the “compliment” was often interpreted as negative, leading to victim blaming.

The fifth event, “mansplain” was the event most often recognized as bias. One participant described the interaction this way:

> “I feel like that was a classic example of mansplaining, explaining something that you could logically assume she would already know. But I think this goes a step further because he asked her if she knew it, and when she said yes, he decided to explain it anyway.”

Those who noted the event as negative (without bias), found the perpetrator to be rude, but not necessarily biased. For example, one participant noted:

> “He [Ethan] didn't let her [Erika] explain if she knew exactly what opportunity cost was or not. Instead, he decided that he should just explain at least what he thinks on it before she had the chance to elaborate…I think it was probably unneeded and rude way to kind of explain [*sic*].”

Individual Participant Narratives

To demonstrate the richness and range of the perspectives of individual participants, I have summarized four of the participant’s narratives. These narratives provide an additional contextual lens and point of view to the nuances and subjectivity of this phenomenological research and represent a range of responses to the video. Participant 25 represents a participant who missed events and had no recognition of bias. Participant 16 represents a more observant participant with a near balance between positive and negative observations of the events, but still no bias recognition. Participant 24 represents a participant who identified all five subtle bias events as negative interactions but did not articulate any of the events as biased. Participant 18

represents a participant who identified all five bias events as negative interactions, and recognized bias in two of them. For the individual narratives I will include their results from the QCAE Empathy measure. Across all 19 participants, the QCAE score resulted in overall M = 3.0, SD = 0.3 on a 4-point Likert scale with 4 being high cognitive empathy.

Participant 25 ~ Two Missed, One Positive, Two Negative Interactions – No Recognition of Bias.

This participant had mixed responses during their observations of the video and did not articulate any of the events as biased. He attended to cues such as ignoring, interrupting, tone of voice, collaboration, challenging ideas, dismissive, and lecturing. He did not stop at all during 2 of the subtle bias events ("note-taking" and "questioning competence"). In other words, the participant didn't deem these interactions as positive or negative. He framed "hepeat" as a positive interaction reflecting effective brainstorming. He perceived that, "no one seemed super upset when a new idea was brought up, or instantly shot it down with any harsh language." He identified it as a "good discussion & teamwork. Constructive and everyone was on the same page…Everyone's idea was building off each other, not attacking." This participant didn't recognize any harmful, rude, or biased behavior during this interaction and had the impression that the team was productive and got things done. The participant categorized two bias interactions as negative ("interrupt/talking over" and "mansplain"). During the "interrupt/talking over" interaction the participant perceived that Ethan:

> "Could have been doing that because he felt like he didn't know enough, or trying to make sure that he was getting his way because he wanted to have control of

it. Or yeah, I guess it would really be more because he wanted to have control of the direction the group wanted to go in."

He attributes Ethan's behavior to a personality trait in this event, suggesting that Ethan is taking on a controlling role in the group. Subsequently, by the time the participant arrived at the final subtle bias interaction he had developed an elaborate mental model of the Ethan character in the video. During his negative stop of the "mansplain" bias his impressions were that:

> "The 2 guys were condescending, and they were not very accepting of her proposed solution, and the guy to the right [Ethan] began to oversimplify things, even though she [Erika] had stated that she had taken an economics class. So she knew and understood basic economics, but he still proceeded to belittle her and oversimplify the problem. You know, kind of subtly hinting at that [sic] she wasn't necessarily smart enough to understand it."

At the conclusion of this interview, despite missing two of the bias interactions and mis-characterizing one as positive, the participant drew on the most egregious behavior(s) witnessed to form his impressions. He discussed instances of the team not being a very inclusive group, explicitly overriding each other, and ignoring. He had the impression that the other 3 team members progressively saw a negative pattern in Ethan's behavior. This participant's QCAE overall cognitive empathy resulted in a mean score of 2.7 on a 4-point Likert scale measuring slightly below the mean average empathy score of all participants in the study.

Participant 16 ~ Three Positive, Two Negative Interactions – No Recognition of Bias.

This participant declared the first three subtle bias events as positive interactions, and the last two subtle bias events as negative interactions. He did not articulate any of the negative events as bias. He was attentive to cues such as headshaking, eye rolling, disengagement, eye contact (and lack thereof), and tone of voice. His mental models of the three interactions were based on perspectives regarding teamwork: that the "note-taking" interaction was typical of a new team and people are hesitant to volunteer; that the "hepeat" interaction was good teamwork in general and the "interrupt/talking over" interaction was an effective ideas exchange. In his words:

"They (the team) were bouncing back ideas and a t-shirt gun was brought up, but no one actually had an idea or like knew exactly how far that t-shirt gun could shoot. So rather than just turn the idea down or just going with it right away. They decide to look into it, do some research." The final two bias interactions were characterized as negative, but not as bias by this participant. The "mansplain" interaction was described as a team member being cut off and explained a concept she was already familiar with. While the "questioning competence" bias interaction was described as a negative interaction due to the body language cues and communication between two teammates. The participant noted:

> "He [Ryan] was complimenting her for being in Calc 3, and saying that was impressive, and all that, but she kind of had negative eyerolls and acted a little bit disgusted and had a disgusted look on her face. So, I'm not sure what that is all about, but it didn't seem like that was kind of warranted. I guess that's why I'd say this would be a negative."

Instead of seeing the woman's response to a subtle bias reflecting assumptions of inferiority, this participant in particular was baffled by the woman's negative response to what he perceived as a compliment. When asked why he believed they behaved this way, he resolved that there was maybe some tension between the 2 team members, building an elaborate backstory about the team's past. He commented that:

> "Some people just don't get along with each other… or maybe there's just some history between the two, where it's just they don't like each other. Maybe, possibly, she just doesn't feel that being in Calc 3 is all that impressive, and she's just heard it many times, and she's annoyed by hearing it."

This explanation by the participant gets at the effects of repeated subtle bias, without actually calling it that.

Throughout his interview the participant attributed several of the interactions to the team's relationships as "not being the best." He acknowledged that Ethan would rant sometimes, and the participant's mental model was that the rest of the team had resentment or tensions with him. By the conclusion of the interview, he expressed being annoyed with Ethan and that the team was used to his behavior of cutting people off. He observed that the team "is just they're used to it (Ethan's behavior) and that's why everyone just had [sic]. There was a bunch of eye rolls, and their body language has changed because they just have that "oh here it comes" type moment." It is interesting that this participant was progressively annoyed with Ethan (similar to Participant 25) but identified 3 of the bias incidents as positive interactions. He seemed to be triggered with annoyance solely on the mansplaining event. It is indicative of how a single negative event can have a strong influence on one's perspective. This participant also attributes Ethan's behavior to his personality, rather than suggesting a systemic cause related to

gender bias in STEM. This participant's QCAE overall cognitive empathy resulted in a mean score of 2.9 on a 4-point Likert scale measuring just below the mean average empathy score of all participants in the study.

Participant 24 ~ Five Negative Interactions – No Recognition of Bias

This participant identified all 5 subtle bias events as negative interactions but did not articulate any of the events as biased. He was attentive to cues such as tone of voice, side eyes, low posture, and disengagement. He extrapolated heavily from each situation, similar to Participant 16, often going into detail on the possible causes of each of the team member's actions and articulating his feelings as a result of his observations. For example, during the "note-taking" event he suggested that Rachel jumped into the task of taking notes, stating, "I feel like she assumed that she was going to have to take notes again, like she always does." When the participant was asked why they thought this individual behaved the way they did, his response was "because she felt compelled to take notes and to take on this assumed role to later hold it over the team's head as her contribution to the team." This is reflective of the tendency to have a preconceived narrative (elaborate backstory) of the characters in the video. Although there wasn't a recognition of bias, on several occasions the participant mentioned that the women should advocate for themselves and/or one another. Plausible reasons provided as to why the women didn't stand-up for themselves or each other were stated as:

> "She [Erika] didn't notice that Rachel was ignored", "she didn't care that Rachel was ignored", or that Rachel didn't stand-up for herself. Based on previous occasions, this behavior has happened over, over, and over again. Maybe they're almost done with this project, and she would rather just finish with the

project and once we finish [*sic*] this project she won't have to deal with them anymore."

When this participant detected the behavior of the men as negative, he didn't view it as ill-intended, but rather that the men were focused on their own interests, task-oriented, or didn't value other's opinions. For example, in reference to the "hepeat" bias, his comments were that "they just ignored her completely, as if she wasn't a member of the team." When asked by the interviewer why he thinks they did that, his response was:

> "Without fully attributing motive it would be hard to say, but I have been in situations where one person's input isn't equally valid, hmm not valid, their opinion isn't prized. They don't think that it's good enough because maybe they are not doing so well in the class, or they had a hard time doing this other thing that I thought was so easy, right? So, I don't think that they recognized her solution as valid, because they think that she's not good at coming up with ideas like this."

Throughout his interview, the participant frequently described his feelings about what he viewed through the lens of each actor and discussed times when he could relate or identify with the interaction, especially when it came to being ignored or left out. This participant's QCAE overall cognitive empathy resulted in a mean score of 2.6 on a 4-point Likert scale measuring slightly below the mean average empathy score of all participants in the study.

Participant 18 ~ Five Negative Interactions – Two Events of Bias Recognition

This participant declared all 5 subtle bias events as negative interactions, and he detected bias in 2 of the 5 negative events. He attended to cues such as team members shutting down, surprised about competency, challenging ideas, low posture and

disengagement. During the “note-taking” event the participant primarily deemed it negative because of Rachel's non-verbal reaction, he stated, “the girl with the blue laptop [Rachel] kinda gave like a little eye roll or eyebrow raise. I would say it's a negative physical reaction to someone and something to do in a meeting like that.” However, the participant also acknowledged that Rachel stepped-up to take the notes, in spite of her negative reaction to Ethan's excuse regarding his handwriting being bad. He later clarified that “I would say partially negative on the guy [Ethan], saying that oh, I’d do that, but I'm not capable of [*sic*], when he is probably capable of doing it, so maybe like that's kind of like a negative.” The participant characterized the “hepeat” interaction as negative because Ethan made the decision of neon orange for the team. By this time of the interview the participant already had an established mental model of Ethan’s dominance and the team’s resignation, stating:

> “I guess it still seems like it's more of one person is controlling [*sic*] more of the conversation or direction of the team. So maybe others are responding to that, maybe seeing kind of what I'm seeing, and they're responding in a way where they're more or less allowing that to kind of go that route, and maybe just let that person make decisions, whether they want that, you know, color or option, whatever. They might just like kinda let the group go that way if the louder more talkative person maybe is on board with it.”

By the time the participant detected his first bias interaction (interrupt/talking over), his observations of Ethan during this interaction were:

> "Once again the male on the right [Ethan] could have pre-existing notions or ideas of the people that he's in this group with. And it seems like maybe he's having a direct conversation with the one guy [Ryan] across from him, while there

> is two other people in the group. so it's possible he doesn't care to listen to them (the women), or doesn't think that what they have to say is as competent or as important to the group as what the guy directly across from him is saying, or what he's saying."

When asked what would drive that kind of behavior the participant responded:

> "I don't exactly know. Possibly an upbringing where you are in situations or have had past experiences where you've either been taught or told. That's I guess [*sic*], in this scenario you could hint that he [Ethan] is believing that whatever this guy [Ryan] is saying is smarter than whatever the two girls in the group are going to say. So I yeah [*sic*], the only thing I can think of is some sort of upbringing where he would have, not necessarily been directly taught that, but possibly in interactions where either friends or family kind of hint that that's sort of the case. Where in the business world men are either superior, you know. It seems like he's taking that route, so I don't exactly know where that can come from."

Thus, the participant is attributing Ethan's belief that women are less competent to how he was raised or through past interactions, while also discussing a societal stereotype that men are superior as explanations for Ethan's behavior.

The second bias detection came during the "mansplain" interaction. The participant stated, "a negative experience from the guy on the right [Ethan] again. Once again talking over somebody and I guess in the ending [sic] some classic mansplaining going on." It was interesting that the participant utilized the word classic in association with mansplaining, as if it is a typical or common phrase. When asked to clarify his definition of mansplaining the participant said:

> “I guess I would think of mansplaining as telling or describing something to a female and just assuming that they have no prior knowledge of it… but when he went right to an explanation, and seemingly like a dumbed down explanation. I think that's more so what I'd assume to be mansplaining. Giving like a really dumbed down explanation of something like assuming that person has like no knowledge of that.”

Having common language to articulate this behavior appeared to aid the participant in quickly recognizing and identifying this event as bias.

By the conclusion of this interview the participant expressed being uncomfortable, upset and annoyed by someone talking over other people. Overall, his impression was that the team lacked proper etiquette in conversation and didn’t effectively listen to others at times. When asked about his overall impression of the interpersonal interactions of the team he stated:

> “My reactions to them were back and forth of good collaborative interactions between the group kinda working up to what they're trying to find. While that was also smashed by interactions that were negative and kind of against other people's ideas, so that was my reaction to that [*sic*]. No one seemed to be stepping up and/or changing how the group was moving there.”

Thus, the participant had the impression that no one was taking responsibility for their actions, holding others accountable, nor improving the interpersonal dynamics of the group. This participant’s QCAE overall cognitive empathy resulted in a mean score of 3.5 on a 4-point Likert scale measuring slightly above the mean average empathy score of all participants in the study.

Taken together, these participants paint a vivid picture of how individuals construct their understanding of the interactions between the team members while simultaneously articulating their negative and positive evaluations of the interpersonal interactions as they felt, interpreted, and communicated them. When comparing all four narratives, there is a trend related to their QCAE empathy scores which offer indications that empathy could play a role in bias recognition.

Thematic Analysis: Card Sorting & Clustering.

As a result of the inductive coding process during pass 3 of the analysis, 36 cues were derived that were used during a card sorting process to derive “blind” themes from assessors who have no contextual knowledge of the study, the research questions, nor my research goals related to bias recognition. Table 23 identifies the 36 cues; 28 were derived from the participants’ negative stops and 10 cues were derived from the participants’ positive stops. As a note, there were 2 cues that overlapped during both negative and positive stops.

Table 23

Themes of Participants' Positive and Negative Stops During the Video

Cues	Type of Stop negative (1) positive (2)	Card Number
Mansplaining	1	1
Tone of Voice	1	2
Hesitate/Pause	1	3
Not Intervening	1	4
Make Excuses	1	5
Disengaged/Quiet	1 & 2	6
Forceful/Taking Charge	1	7
Interrupting	1	8

Talking Over	1	9
Ignoring	1	10
Dismissive	1	11
Ideas Not Heard	1	12
Questioning/Challenging Ideas	1	13
Eye Roll	1	14
Raised Eyebrows	1	15
Pairing Up/Excluding	1	16
Taking Credit	1	17
Shutting Down	1	18
Stare Down	1	19
Sitting Back/Low Posture	1	20
Side Eye	1	21
Raising Voice	1	22
Calling Out	1	23
Compliment	1 & 2	24
Lecturing	1	25
Lack of Eye Contact	1	26
Leaning Forward	1	27
Surprised About Competency	1	28
Gesticulate	2	29
Relating With Each Other	2	30
Team Brainstorming	2	31
Collaborative/Not Dismissive	2	32
Nodding/Headshaking	2	33
Volunteer For Task	2	34
Invite Others Into Conversation	2	35
Small Talk	2	36

I conducted a moderated/in-person card sorting with physical cards (Righi et al., 2013) with a group of students enrolled in a Cognitive Task Analysis (CTA) class at

Michigan Tech. The class consisted of 10 students (4 undergraduates and 6 graduates). I was present during this class session to assist as well as to actively listen to how the students discussed and went about making their sorting decisions.

The students were given the prompt that the cues provided are “cues observed during a 4-person team project meeting.” They were issued an instruction sheet (see Appendix E) as well as two separate stacks of cards (stack 1 (negative cues) and stack 2 (positive cues)). Each card had the cue listed on one side and its associated card number on the opposite side. The students worked in pairs; each team began with stack 1. They were told to “take a few minutes to sort stack 1 cards into groups (clusters) of cards (features, cues) that you think go together. There is no right or wrong answer here.” As one person worked through their process of sorting through stack 1 the other person was the observer and note taker. They utilized data collection sheets to write down the sorter’s categorical names and their corresponding numbers. Once they completed sorting stack 1, the same sorter completed sorting stack 2. Then the second person completed the same process, while their partner completed their data collection sheets. This process is referred to as an open card sort where the card sorting process allows participants the autonomy to organize their cards into their own categories and labels (Righi et al., 2013).

As a result of the card sorting cues analysis, an item-by-item matrix was calculated to determine the strength in the relationship among each of the item pairs (Righi et al., 2013). Figure 9 and Figure 10 respectively represent the positive and negative relationships and show the number of students who paired each set of cards.

Figure 9

Item-by-Item Matrix of Positive Cues

Positive Cues											
Disengaged/Quiet	**6**		1	3	0	0	1	4	1	0	2
Compliment	**24**	1		4	5	1	1	3	4	4	4
Gesticulate	**29**	3	4		1	2	1	4	2	1	1
Relating With Each Other	**30**	0	5	1		3	2	1	1	4	5
Team Brainstorming	**31**	0	1	2	3		9	2	7	6	1
Collaborative/Not Dismissive	**32**	1	1	1	2	9		3	5	3	2
Nodding/Headshaking	**33**	4	3	4	1	2	3		2	0	1
Volunteer For Task	**34**	1	4	2	1	7	5	2		5	1
Invite Others Into Conversation	**35**	0	4	1	4	6	3	0	5		5
Small Talk	**36**	2	4	1	5	1	2	1	1	5	

Note: The bolded numbers correspond with the card numbers and cues in Table 23.

Figure 10

Item-by-Item Matrix of Negative Cues

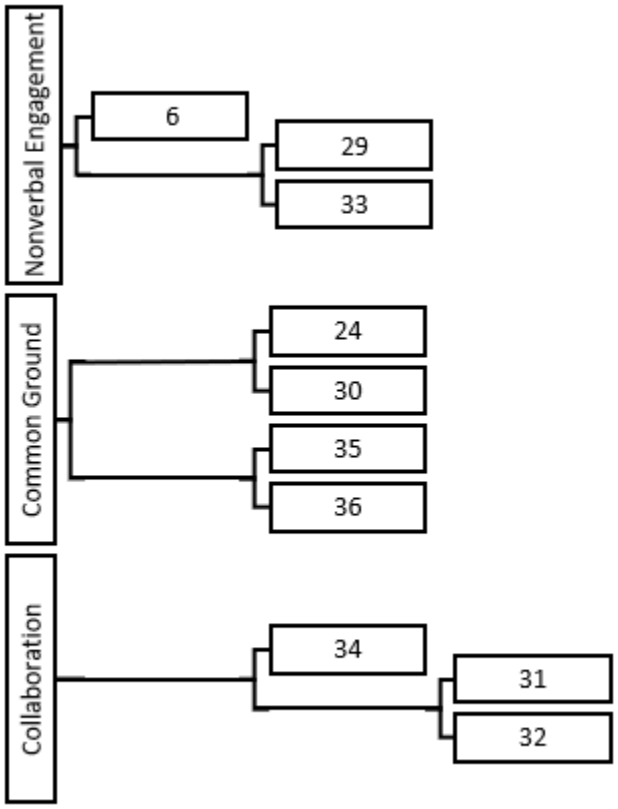
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Mansplaining	**1**		2	0	1	5	0	5	6	8	3	6	0	1	2	0	3	3	3	1	0	1	5	2	0	5	0	0	1
Tone of Voice	**2**	2		0	1	3	2	2	5	4	1	1	0	3	2	1	0	2	1	2	1	1	4	6	2	4	1	2	2
Hesitate/Pause	**3**	0	0		5	1	5	1	1	0	3	0	5	1	1	2	2	1	4	3	5	3	1	0	1	1	8	3	2
Not Intervening	**4**	1	1	5		3	7	0	2	1	4	3	6	1	1	1	2	1	5	2	4	3	0	1	1	0	6	1	1
Make Excuses	**5**	5	3	1	3		2	1	4	4	3	5	3	2	0	0	3	3	4	1	3	0	3	2	0	3	2	1	3
Disengaged/ Quiet	**6**	0	2	5	7	2		0	0	0	3	2	5	1	2	2	1	0	5	3	6	4	0	1	1	0	8	2	1
Forceful/ Taking Charge	**7**	5	2	1	0	1	0		4	4	3	4	0	2	3	0	1	5	0	1	0	2	5	2	3	4	0	1	2
Interrupting	**8**	6	5	1	2	4	0	4		9	2	4	0	2	1	0	1	4	4	2	0	0	7	5	0	6	0	1	2
Talking Over	**9**	8	4	0	1	4	0	4	9		3	5	0	1	2	0	3	3	4	1	0	1	8	4	0	7	0	0	1
Ignoring	**10**	3	1	3	4	3	3	3	2	3		6	4	0	2	1	4	3	3	2	5	4	2	0	0	1	5	1	2
Dismissive	**11**	6	1	0	3	5	2	4	4	5	6		1	1	3	0	4	3	3	0	2	2	4	1	0	3	0	0	2
Ideas Not Heard	**12**	0	0	5	6	3	5	0	0	0	4	1		1	2	2	3	0	3	3	7	4	0	1	0	1	7	2	2
Questioning/ Challenging Ideas	**13**	1	3	1	1	2	1	2	2	1	0	1	1		1	3	1	2	1	1	1	1	2	4	4	3	0	4	2
Eye Roll	**14**	2	2	1	1	0	2	3	1	2	2	3	2	1		3	4	2	0	3	5	8	2	2	0	3	3	2	2
Raised Eyebrows	**15**	0	1	2	1	0	2	0	0	0	1	0	2	3	3		3	0	0	4	4	5	1	0	3	1	4	7	3
Pairing Up/Excluding	**16**	3	0	2	2	3	1	1	1	3	4	4	3	1	4	3		2	1	3	4	4	1	0	0	1	2	1	0
Taking Credit	**17**	3	2	1	1	3	0	5	4	3	3	3	0	2	2	0	2		1	2	0	2	1	1	1	0	0	1	3
Shutting Down	**18**	3	1	4	5	4	5	0	4	4	3	3	3	1	0	0	1	1		1	3	2	3	1	0	3	5	1	2
Stare Down	**19**	1	2	3	2	1	3	1	2	1	2	0	3	1	3	4	3	2	1		4	5	0	1	0	0	4	4	2
Sitting Back/ Low Posture	**20**	0	1	5	4	3	6	0	0	0	5	2	7	1	5	4	4	0	3	4		4	0	1	0	1	7	3	1
Side Eye	**21**	1	1	3	3	0	4	2	0	1	4	2	4	1	8	5	4	2	2	5	4		1	1	0	2	4	2	2
Raising Voice	**22**	5	4	1	0	3	0	5	7	8	2	4	0	2	2	1	1	1	3	0	0	1		5	1	8	0	0	2
Calling Out	**23**	2	6	0	1	2	1	2	5	4	0	1	1	4	2	0	0	1	1	1	1	1	5		3	7	0	2	2
Compliment	**24**	0	2	1	1	0	1	3	0	0	0	0	0	4	0	3	0	1	0	0	0	0	1	3		2	0	5	2
Lecturing	**25**	5	4	1	0	3	0	4	6	7	1	3	1	3	3	1	1	0	3	0	1	2	8	7	2		0	0	2
Lack of Eye Contact	**26**	0	1	8	6	2	8	0	0	0	5	0	7	0	3	4	2	0	5	4	7	4	0	0	0	0		3	1
Leaning Forward	**27**	0	2	3	1	1	2	1	1	0	1	0	2	4	2	7	1	1	1	4	3	2	0	2	5	0	3		5
Surprised About Competency	**28**	1	2	2	1	3	1	2	2	1	2	2	2	2	2	3	0	3	2	2	1	2	2	2	2	2	1	5	

Note: The bolded numbers correspond with the card numbers and cues in Table 23.

Item pairs with the highest number association represent a stronger level of agreement between items. Following the protocol by Alam and Mueller (2022) I leveraged the *agnes* agglomerative hierarchical clustering function in the clustering package of *R Statistics*, which is a globally accepted statistical software package Agnes clustering aid in assessing the optimal associations based on the matrices. It is a bottom-up approach to clustering which finds cues that are small, but highly similar and clusters them together within structures or groupings. The dendrograms Figures 11 and 12 represent the positive and negative clustering of cues based on the class' card sorting activity.

Figure 11

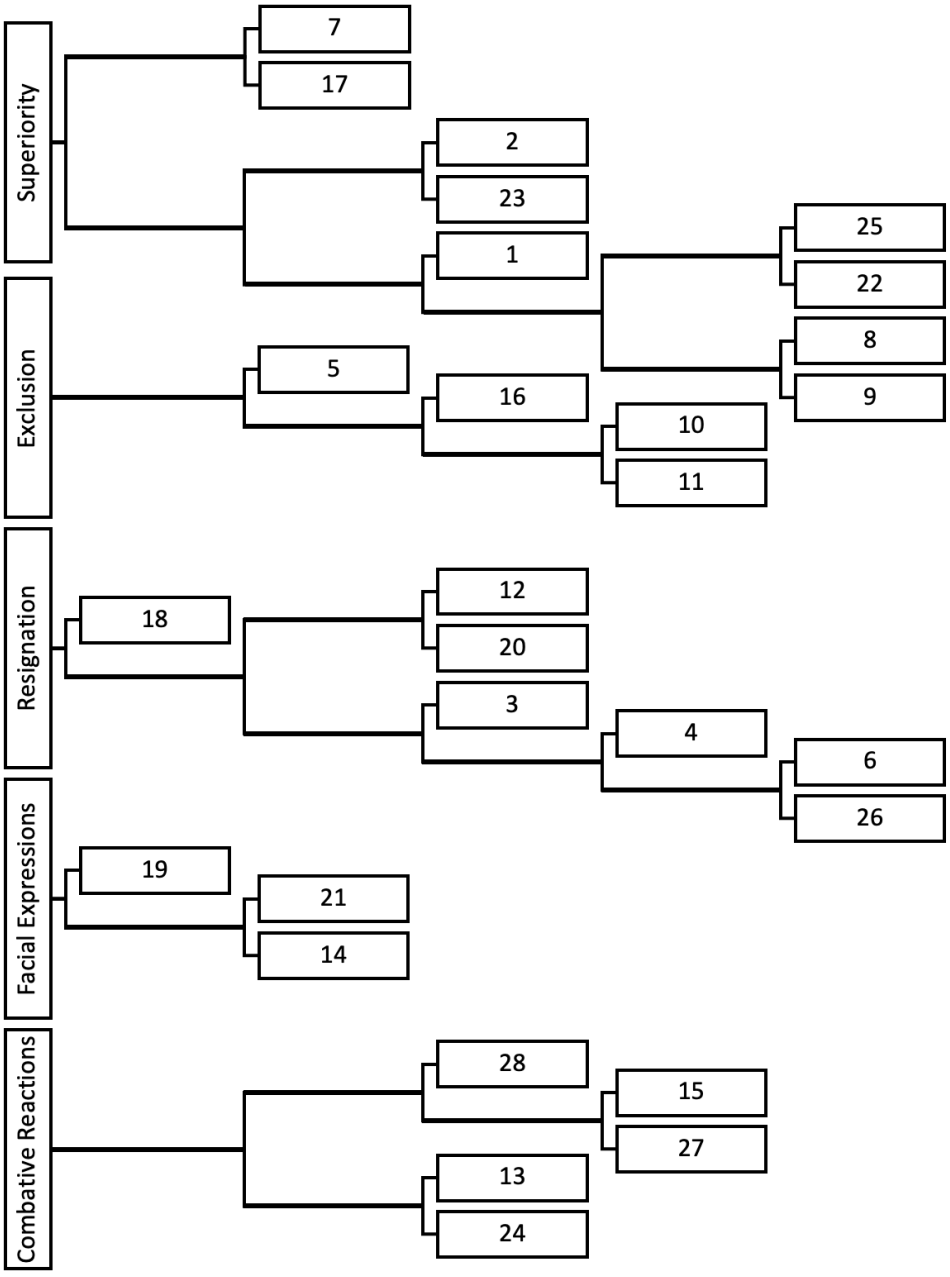
Hierarchical Clustering of Positive Cues



Note: The numbers correspond with the card numbers and cues in Table 23.

Figure 12

Hierarchical Clustering of Negative Cues



Note: The numbers correspond with the card numbers and cues in Table 23.

The process of blind card sorting, matrix indexing, and designing a dendrogram is a rigorous data analysis approach that provides an analysis process uninfluenced by preconceived notions related to bias. Furthermore, a consistent criterion was utilized during the card sorting protocol to maintain a consistent procedural structure. A detailed analysis of card sorting, and cluster analyses of the dominant cues revealed 3 positive themes and 5 negative themes. I closely examined each of the dendrograms to create labels for the themes that articulate the nature of the cues. After creating the labels, I returned to the CTA class to reveal the purpose of the research as well as share the dendrograms that were produced as a result of their card sorting activity. Additionally, I discussed the thematic labels with the students to gain additional consensus of the labels chosen.

Positive Cues Themes.

Theme ~ Non-Verbal Engagement: Cues related to non-verbal engagement reflect behaviors that convey one's engagement (or lack thereof) and response during interactions. For example, gesticulating can be a way of supplementing verbal communication. Alternatively, being disengaged and quiet can reflect a lack of active engagement or a disinterest in contributing to a conversation. These behaviors collectively contribute to the nuances of non-verbal cues and the dynamics of interpersonal interactions.

Theme ~ Common Ground: Cues related to common ground reflect ways that interpersonal interactions foster a positive, friendly, and inclusive atmosphere. They promote shared interest, building rapport, effective communication, and a way to create connections.

Theme ~ Collaboration: Cues related to collaboration reflect interconnected behaviors and actions that contribute to effective group dynamics. They create a productive environment where ideas flow freely, contributions are valued, and tasks are undertaken willingly. These types of interactions maximize the potential of each individual in the team to achieve positive team outcomes.

Negative Cues Themes.

Theme ~ Superiority: Cues related to superiority reflect communication dynamics that can often be associated with issues related to power, gender dominance, and social interactions. For example, in mansplaining a man will posit authority, dominance, and/or more knowledge over a woman during an interaction. While voice tones are indicative of asserting dominance, aggression, belittling, and/or power playing.

Theme ~ Exclusion: Cues related to exclusion reflect behaviors of interpersonal dynamics such as power struggles or conflicts. For example, a person may make excuses, ignore another person, or be dismissive as a way of forming an alliance against others. These behaviors can have unfavorable outcomes within group dynamics.

Theme ~ Resignation: Resignation includes cues that reflect feelings associated with an unsupportive or non-inclusive working environment. These types of behaviors can result in a decline in group participation, diminished productivity, and a decline in self-expression and respect within the team.

Theme ~ Facial Expressions: Facial expressions include cues that reflect non-verbal forms of communication involving the use of facial reactions and eye contact. For example, the dynamic of a stare-down can be interpreted as a confrontational expression to communicate seriousness or a way of challenging another person. They can also be viewed as subtle forms of communication to express one's feelings instead

of using words. While these behaviors may not always have an ill intent, they can have a negative impact when and if the intent of these behaviors are not clarified or left to interpretation.

Theme ~ Combative Reactions: Cues related to combative reactions reflect ways in which individuals may express strong feelings through verbal and nonverbal communication. For example, challenging the ideas of other team members or being surprised by someone's competency. The misuse or overuse of these forms of communication can contribute to a hostile team environment. While these behaviors may not always have an ill intent, they can have a negative impact when and if the intent of these behaviors are not clarified or left to interpretation.

Summary of Feelings

Overall, 13 participants characterized at least one of the five bias events as positive (18 individual characterizations), all 19 participants characterized at least one of the bias events as negative without bias (54 individual characterizations), and 9 participants characterized at least one of the bias events as negative with bias (13 individual characterizations). When asked about how these characterizations made them feel, participants tended to use broad sweeping phrases (e.g. feeling good or bad). When pressed to describe these feelings in more detail, rather than doing so, they would often describe what happened in the event or describe what they thought the people in the event might be feeling. This caused the categorization of the feeling of the participants to be based on less data in comparison to the cues and mental model results. In response to perceived positive interpretations, when addressing their own feelings, participants most often responded that they felt good or positive (7 participants). Less often they mentioned being glad, comfortable, hopeful or feeling safe

(1 participant each). One participant noted a sense of familiarity with the scenes. In response to perceived negative interpretations (both with and without bias), 13 participants expressed general negative or bad feelings with 4 reporting feelings of being unhappy or displeased. Specific negative affects included feelings of discomfort (awkward, uneasy, uncomfortable, off-putting and cringy) expressed by 7 participants, alarmed and wary expressed by 2 participants, and agitation (annoyed, agitated, tense, perturbed, frustrated, confused, or upset) expressed by 13 participants. Four participants expressed feelings of disengagement, including not wanting to be a member of the group or not continuing to contribute or care about the group. While 5 participants expressed a sense of empathy through familiarity with the situation or sympathy/ empathy for the individuals. There were no major differences in feelings between participants who noticed or did not notice bias. Although bias recognition did elicit a feeling of disappointment among 2 participants which was not expressed by participants without bias recognition. As participants encountered and recognized more negative events, their feelings often progressed from unhappiness and alarm to discomfort and agitation, and then disappointment, disengagement or empathy towards the target.

Mental Model Clusters

As a result of the three-phase transcription and coding process, mental model clusters were developed to describe and interpret the overall perspectives of the participants and their narratives. Five clusters were developed when participants didn't notice bias and three clusters were developed when participants noticed bias interactions (See Table 24). The non-recognition clusters are 1) efficient teamwork, 2) in-group affinity (the dynamics and interactions among team members), 3) individual personalities/traits/ experiences (how participants attributed the behavior of the

perpetrators of subtle bias), 4) elaborate team backstories (participants tendencies to discuss non-confounding justifications for the bias events they observed), and 5) victim blaming (explanations attributed to the overreaction of the women on the team to bias events). The bias recognition clusters are 1) common language/terminology (mainstream vernacular used to explain bias), 2) emotional intelligence (EQ) (the perpetrator's lack thereof), and 3) empathy (the perpetrator's lack thereof).

Table 24

Mental Model Clusters

Metal Models of Participants Who Didn't Recognize Bias	Mental Models of Participants Who Did Recognize Bias
Efficient Teamwork	Common Language/ Terminology
In-Group Affinity	Emotional Intelligence
Individual Personalities/Traits/ Experiences	Empathy
Elaborate Team Backstories	
Victim Blaming	

The rigor of the coding has aided in developing these phenomenological clusters and making sense of these data to develop shared meaning and patterns. The evolution of these categorizations developed organically and reflected the distinctions of the participants' responses, feelings, and mental models in a meaningful form. While each participant's individual perspectives were unique, these themes unveil broader insights into the phenomenon of exposure to subtle gender bias among majority members within STEM project teams.

Mental Models of Participants Who Didn't Recognize Bias

Efficient Teamwork: At the onset of viewing the video participants were readily able to identify how the team started with a strong sense of camaraderie which initially established cohesion. For example, during the "note-taking" event one participant mentioned, "when the first guy [Ethan] started speaking, everybody was making eye contact and making sure that the meeting could begin on a good note, and that everybody knew what was going on." Several participants articulated this event in a similar manner by discussing that this mental model draws upon the specific cue theme of common ground. When referring to the first few scenes of the video another participant mentioned:

> "I personally think that small talk in a group setting is a positive trait. I think, just the casual small talk like that, bringing up personal experiences can be pretty positive for these group scenarios because it helps create bonding between teammates. Even if, [*sic*] personally I don't think everyone even needs to speak up for their own experiences, just having people to talk to as the sole speaker is a nice and helpful way to let everyone know about you and just have the understanding that they better understand you."

This participant saw value in how the team established rapport in the first few scenes by discussing things such as looking at the camera and growing up on a lake. These quotes from participants speak to the importance of an efficient team to make connections professionally and personally by clarifying tasks that needed to be completed while leveraging small talk to build strong team alignment.

In-Group Affinity: As participants viewed the video and team interactions there were a range of observations related to how the team members interacted with one

another. This category revealed three particular interpretations, “in-group affinity”, “exclusion of women”, and “lack of respect” by demonstrating the varying ways participants described the bias interactions of their peers but did to acknowledge the behaviors as biased. This mental model draws upon the specific cue theme of exclusion. For example, one participant mentioned that:

> “It seems like the guys are just talking over the two people in the back (the women). Kinda also being dismissive of other people’s input. It seems like maybe the guys feel a connection because they're guys, and you know, they could keep talking about it because they were relating. They were on the same page about the conversation, the track it was going [*sic*]. But weren’t really giving any chance to the other two to give their input and really acknowledging it (their input) at all”

This participant detected exclusion happening but justified the interaction between the two men as connectedness and due to their gender affiliation.

Additionally, women were often seen as excluded from some of the discussions of the team. For example, one participant mentioned the women being excluded during the “hepeat” event, when asked by the interviewer “why do you think the women were excluded”, he explained that that the two men were:

> “Either in a rush to get the project [*sic*] or like trying to get this done with whatever task they need to get done. So, sounds like a good idea trying to either rush through it faster, or there's just, [*sic*] or they're not necessarily taking the girls seriously, or whatever [*sic*]. Or something along those lines, hard to necessarily tell.”

Lack of respect was another area consistently noted by participants. The undertones of lack of respect and trust drove interpretations among participants of

moments when the team flourished as well as when the team interactions were strained. One participant noted that:

> “Three of the members were really good with their interpersonal connections. But he [Ethan] could use some work. I think he was somewhat rude and did not respect the girl on the left [Erika] when he she brought up ideas and did not communicate well. He talked over her, and I think failed in terms of respecting his group members.”

Another participant mentioned during the “interrupt/talking over” event that:

> “He [Ethan] cut her [Erika] off with like no disregard at all, and didn't apologize, or anything. She kind of just didn't get her idea heard, and the worst part was that they were conflicting ideas. So, if they didn't explore her idea. it might end up going down the wrong solution."

This participant speaks to Ethan’s lack of trustworthiness of Erika’s ideas as a contributing member of the team. Another participant said that during the “hepeat” event “they [the men] just have more confidence in their own ideas than anybody else…I guess, not necessarily trusting anybody else to have a good idea, and only thinking that it’s good when it comes from you.” In this instance the participant associated the behavior of the men to a lack of trust in Rachel’s ability to contribute ideas to the team.

Individual Personalities/Traits/Experiences: As participants viewed the video and team interactions there were several collective impressions related to the personality traits and experiences of the individual who most consistently displayed subtle bias behavior (the Ethan character in the video). Overall, there were three personality traits that were often associated with participants’ impressions of the intentionality of this individual: “superiority”, “task-orientation”, and “dominance”. These

personality traits were often used to suggest that this was Ethan's typical behavior and that he was not intentionally engaging in negative behaviors. This mental model draws upon the specific cue theme of superiority. Participants occasionally clarified the intent of the perpetrator, even when there was a detection of bias. For example, one participant mentioned observing a negative interaction as "not particularly of malice or bad intent", instead he described Ethan as "socially inept" and he behaved that way due to his personality.

The theme of superiority was applied by participants to Ethan due to his tendency to discount others, believe that he was smarter than the other team members, and believe that he knew more than his team. One participant noted during the "mansplain" bias event that "he [Ethan] didn't let her [Erika] explain if she knew exactly what opportunity cost was or not. Instead, he decided that he should just explain at least what he thinks on it before she had the chance to elaborate". As a result of observations such as these, one participant made the generalization about Ethan that he was a "know-it-all." For example, during the "note-taking" bias event of the video, one participant mentioned that they wouldn't perceive Ethan's handwriting as a "real reason" why he didn't take the notes for the meeting. When asked what they think the real reason would be, they discussed that Ethan's behavior is "built out of laziness as they [Ethan] just don't want to do it. Maybe they see themselves above that kind of work, or more important to the team than to do something like taking notes." Several participants also acknowledged using this excuse themselves, resulting in attributing the behavior to personality instead of the stereotype that women are more suited to non-technical roles in the team.

Another characteristic often assigned to Ethan (and sometimes to both men) was being focused and task oriented. For example, one participant mentioned that "...he [Ethan] controlled the direction of the meeting and delegated tasks." Some participants described this behavior as productive, results-oriented and goal-driven, often casting this as a positive personality trait. However, another participant commented that "the men were trying to get the task done, rushing through it, not taking the women seriously."

Another trait often assigned to Ethan by participants was dominance and a strong sense of authority. Participants frequently identified Ethan as the leader of the group. However, some participants deemed his behavior as aggressive and authoritative. One participant who saw Ethan's behavior as aggressive mentioned that "he was trying to get his way, he wanted to have control and direction of the group." Another participant observed that "I think he [Ethan] probably has strong opinions on who in the team he sees especially valuable. He presents himself as a dominant team leader." Ethan's dominance was not generally viewed as a favorable characteristic. He was perceived as having the inability to consider others' perspectives and collaborate with his team members.

Participants also perceived that Ethan was just being himself and there wasn't any underlying intentionality connected to his actions. Consequently, there wasn't an association of his behavior to the subtleties of gender bias. One participant explicitly stated, "I didn't think he [Ethan] was intentionally having an attack against her [Erika], he wasn't being aggressive, he just thought that he had a good idea and he was impatient to get it (his idea) out there."

Elaborate Team Backstories: As participants viewed the video and team interactions there were several collective mental models that participants relied upon to

justify why team members interacted the way they did. These were “low morale”, and “confidence”. Participants used these collective models as explanations for behaviors that impacted the team’s interpersonal interactions. This category heavily incorporated the participant’s mental model of their preconceived impressions related to individual team members and/or the assumed behavior/interactions of the team prior to the video interactions they observed.

As part of elaborate backstories development, one of the rationales for negative behavior that participants discussed was low morale of team members. There was a notion that morale could have a ripple effect on the progress and effectiveness of the team. For example, one participant mentioned “I'm assuming that she's [Rachel] unhappy with her teammates, and it will just probably overall reduce her morale and work ethic for the particular project; and then that could potentially bring everybody else down in turn.” Participants expressed low morale as a trigger in which subtle cues can reinforce and/or withdraw members of the team.

During the “questioning competence” bias event, a participant blamed Erika for calling Rachel out and making her feel uncomfortable. When ask what he noticed, he commented that:

> “It’s negative in a weird way. How the girl on the left [Ericka] specifically called out the girl on the right [Rachel]. There’s almost like a pinpoint directed at her, instead of opening to the group, because the gentleman on the right never voiced his opinion.”

This participant primarily addressed the interaction between the two women, and created an elaborate backstory of pitting them against one another. As if to suggest that Erika

had a motivation to intentionally target Rachel. When asked what cues he noticed, he indicated:

> "How she [Erika] just called her [Rachel] out by name instead of leaning out toward a general communication. So she [Erika] kind of forced the girl on the right [Rachel] to give her opinion or give her answer on the topic. It felt off in a way, I could say it's a negative (interaction). It almost made her feel uncomfortable from my perspective, almost made me feel uncomfortable."

This participant further clarifies here that his backstory of the target-against-target interaction made him feel uncomfortable by the way that Rachel was singled out during this interaction. It seems as if the participant was hyper vigilantly attending to the interaction between the women as his comment is indicative of the interaction being negative due to the behavior of out-group members versus in-group members.

Victim Blaming: The phenomenon of victim blaming is holding one accountable for what happened to them is a faulty attribution that is commonly used to explain events. Several instances of victim blaming was a mental model outcome from participants in this study. Following the "note-taking" event a participant said:

> "The leader of that meeting was, you know, asking for help and someone offered, but they didn't sound like very enthusiastic to help so, and you know that kind of like atmosphere won't make anything fun in that project, if that makes sense."

The participant was holding the target accountable for how she responded to the request to take notes rather than recognizing that her response may have been influenced by the subtle bias event of suggesting that women should take on non-technical roles in STEM teams. Consequently, this participant focused on the response of the target as the reason for declaring this interaction as negative.

A different participant stopped this event and declared it as a negative interaction. He stated:

> "I think that's kind of a negative interaction by the girl on the far right [Rachel]. Just kinda like her body language and how she like approached saying something to whoever that might be, their team lead (referring to how Rachel responded to Ethan, whom of which the participant perceived as the leader of the team)"

When was asked about the key things he noticed to identify the interaction as negative, he said:

> "I think first it was the body language, and then it was what she [Rachel] said on top of it. Eye rolling, kind-of the face she made. Like it was just kind of like a negative sort of face, and then what she said as well."

Again, this participant is holding the target responsible for the negative interaction.

Among the 5 events of bias, "questioning competence" had the widest array of responses from participants. As the only event where bias was not detected by any of the participants, it was also the event where there was the highest level of "no stopping" and "victim blaming" by participants. A participant who deemed this interaction as negative commented that:

> "It started out positive with the guy [Ryan] bringing something in that they could relate on…this might be a little far off, but it seemed like the girls were a little high and mighty about it, and they kind of had a little bit of a negative response back to it (the comment)."

Additional comments such as negative eyerolls and a disgusted look on her face were sentiments among participants observations that were coded as victim blaming during this interaction.

Mental Models of Participants Who Recognized Bias

Participant's knowledge of bias terminology, recognition of a lack of EQ on behalf of the perpetrators in the video, and a lack of empathy on behalf of the perpetrators in the video were the overarching contributors to participants' mental models when they detected bias events. When participants noticed behaviors such as disparities in the treatment of others, reinforcement of stereotypes, or unfavorable body language they were better able to articulate the presence of gender bias.

Common Language/Terminology: Among the 5 bias behaviors in the video, the term mansplaining was the only bias behavior consistently mentioned using exact terminology. Each time participants recognized mansplaining they discussed it as if it was a common phrase known by their peers. Nonetheless, the researchers asked participants to clarify their definition of mansplaining to solidify their understanding of the terminology and its association to bias behavior. For example, one participant stated "70% of girls who are assertive enough to stop and bring it up would say he's [Ethan] about to mansplain something. He wanted to project what he knew by asking her [Erika] the question."

Another, less commonly used term was the word "sexist" when describing the bias behavior. There were times when participants suggested that Ethan might be sexist. It's important to note that although the participant ultimately did have recognition of the bias behavior, he first discussed an alternative explanation (an elaborate backstory) before arriving at bias:

> “Maybe he [Ethan] just has a previous relationship with her [Rachel] or has some sort of bad thought of Rachel or maybe she's just not picking up her weight of the work in the group or something, or it could be sort of like a sexist thing.”

There were also instances when participants assigned this characteristic jointly to Ethan and Ryan:

> “It could be like a sexist thing. It could be they just have more confidence in their own ideas than anybody else’s [*sic*]; could be like a narcissistic thing. It also could just be like a more confidence in yourself than anybody else, like not, I guess [*sic*], not necessarily trusting anybody else to have a good idea [*sic*], and only thinking that it's good when it comes from you.”

Another participant mentioned that “there's some sort of discriminatory idea with the two guys. Maybe it's a ‘women can't be engineers’ kind of thing, or racism thing, or sexism thing. They really seem not caring about them in the slightest and not respecting them.” Thus, one of the key indicators in the participants ability to detect bias revolves around having the use of common vernacular to describe the behavior.

Emotional Intelligence: Participants also often articulated that the perpetrator had a lack of EQ when they detected bias behavior. They discussed noticing when individuals were ignored, disregarded, talked over, and blown off, demonstrating when one or both perpetrators had an inability to navigate the social interactions of the team or build collaborative relationships within the team. One participant noted that:

> “These guys are working out their ideas, you know, trying to figure out a concept to move forward. But she [Erika] is just getting completely blown off. She's just not being listened to. their focus is just on another person. They're not taking her ideas into account, you know. Not listening to her for certain, you know. They’re

not appreciating her ideas, or at least giving her the chance to speak. It's almost like she's not there. They just don't see her there at all. They both have just kind of shut her out of the conversation, and she's not going to get her point across, cause they're not valuing her opinion anymore."

Participants discussed the perpetrator's inability to self-regulate or adapt to the dynamics of the team, one participant's perspective was that the perpetrator was "being pretty rude… being somewhat of a typical guy who will talk down to a girl, even if she has equal qualifications." When asked what he meant by typical guy, the participant goes on to say:

> "My idea is somebody who doesn't think about the emotional aspect first, kind of thinks [*sic*] more, not necessarily logically, but just down to numbers [*sic*]. So if he wants something done, that's what's going to happen, that's what he's going to talk about. He's not really considering other people."

EQ was a skillset that these participants deemed as worthwhile to discuss and a noteworthy characteristic within the context of leadership in teams. Thus, team members demonstrating a lack of EQ was perceived as a detriment to the success of the project and cohesion of the team.

Empathy: Another contributor to the ability to recognize bias was recognition of a lack of empathy on the behalf of the perpetrator. Participants made distinctions between empathy and EQ. When they addressed empathy, they spoke to the team member's abilities to put themselves in another's shoes. They also associated the behaviors of team members who lacked empathy as rude, inconsiderate, and condescending. During the "hepeat" event, one participant noted that:

> “It just seemed like she [Erika] had a good idea. And this guy [Ethan], probably internally, also had an idea, and he wanted to get it out there. But I don’t know, it was kind of inconsiderate to just brush her idea off and then of course, the rest of the team kinda just kept going with it, and just left the girl standing alone.”

In this event, Ethan lacked the ability to see Erika’s perspective through his eyes, in other words, he didn’t make an attempt to connect with Erika’s ideas or engage her into the dialogue. Another participant made the comment:

> “When she [Erika] introduced this solution to the issue. He [Ethan] just didn't want to work with that solution in any way. Instantly. Just kind of shooting it down, and his response was not set up in a way where it allowed for a discussion. It was just a kind of you know [*sic*]. I don't think that's gonna work, that's it. And he just didn't seem to be looking to engage into further conversation with her solution.”

As the interactions in the video evolved, participants expressed that the lack of empathy was reflected in the level of confidence the team members had in one another’s decisions and abilities.

Divergent Interpretations

When conducting phenomenological research, an anticipated aspect of the research process and findings are divergent interpretations by participants. These types of interpretations can occur because of pre-existing assumptions, lived experiences, family/society influences, social relationships, or one’s own biases. While these were present, they weren’t generalizable interpretations across all of the participants. Table 25 provides five examples of divergent interpretations expressed by participants for each of the 5 subtle bias events in the video. Individuals constructed meanings as they observed the interactions that were inconsistent with their fellow participants. They were not

always objective in what they were viewing and naturally brought in their own preconceived interpretations. When participants were asked to elaborate on why they believed respective members of the team members in the video behaved the way they did, these elaborate responses seem to stem from a need to come-up with an explanation for the behaviors they observed, rather than admitting that they did not really have a good reason.

Table 25

Divergent Interpretations of the Subtle Bias Events

Subtle bias event	Divergent interpretation and participant quote
note-taking Participant 24	Rachel wanted to take notes for ulterior motives "It felt like she [Rachel] wanted to be the one to take notes but didn't want to seem enthusiastic about it again. Not to attribute motive, but I've been in situations where people have taken on a role that isn't enjoyable so that they can hold it over other people's head saying that 'I'm always the one that's contributing so much'"
hepeat Participant 23	Members of the team are flirting with one another "The red shirt girl [Rachel] was being flirtatious with the black shirt girl [Erika]. She [Rachel] might have felt like her advances were not being reciprocated, and so she's [Rachel] not happy anymore about that."
interrupt/talking over Participant 17	Team members are putting down a male member of the team "The guy on the left [Ryan] had an idea with a t-shirt cannon, and then everybody else, except for the woman on the right [Rachel] kind of immediately started coming up with reasons why it was a bad idea. Like just kind of putting his idea down instead of trying to build on it and work with it."
questioning competence Participant 2	Ryan is jealous of Rachel "I thought it was positive for him [Ryan] to compliment her [Rachel] even though it's rather than he's maybe slightly jealous to himself [sic], but he still is able to compliment her that she was at a higher course."
mansplain Participant 19	Ethan will do the project by himself "The guy on the right [Ethan] just thinking that he knows what's generally best and would probably do this project by himself if it wasn't as much work as it was."

Actions to Improve & The Importance of Context

The results reported for this chapter mostly centered around the first portion of the interview questions from Study 3 which focused on the scenes participants deemed as positive and negative, the cues they observed, emotionality, and the metal models of

their observations. The second portion of interview questions centered around participants' overall impressions of the team and individuals on the team, such as what the team did well and poorly, who they attended to the most and deemed the leader, as well as strategies they would leverage to improve the interpersonal dynamics of the team. Additional analysis can be explored in the future, however there are two key outcomes from the second half of the interviews that are particularly relevant to this study. First, in alignment with the Haynes-Baratz et al., (2022) study, I wanted to investigate bystander actions when witnessing subtle gender bias events. Participants were asked to shift from being an observer to considering that they are a member of this team and discuss what they would have done to improve the interpersonal dynamics of the team. This question was designed to determine if participants would introduce any interventions to bias behavior as well as their decision making processes.

The interventions from those who recognized bias and those who didn't recognized bias were similar in nature. Cultivating systems for sharing ideas was the most notable intervention. For example, a participant discussed:

> "Maybe asking her [Rachel] opinions on things as she kind of just seemed like she was drifting in and out of the conversation. Maybe trying to pour back into the conversation, or see what she has to say, and ask her what's your take on that."

As a way of engaging one of the women in the group that he noticed was less engaged. Another participant hoped for the perpetrator to self-correct, stating "Maybe they [Ethan] would get the idea that the way they're acting isn't likeable, and they would change without you even having to say anything."

Another consistent intervention discussed by participants was to talk to Ethan. Some participants discussed an indirect approach, such as "I feel like I would have like

[*sic*], to just tell the guy on the right [Ethan] like, hey, guys, let's hear everybody out, you know, hear what they have to say. Not just jump around." While others discussed a more direct approach, such as "I'd address the guy in the right [Ethan] and explain that what he's doing is not helpful to the group. He needs to sort of understand that everybody's equal in this group." For those who discussed addressing Ethan, some took the approach of addressing him in front of the team while others mentioned addressing him one-on-one.

The second point worth mentioning that was discussed with participants during the second portion of the interview related to the contextual nature of the interaction. Participants were told to continue considering that they are a member of this team, and they are planning for a future meeting. They were asked about their plan or strategy to address better performance in terms of the team's interpersonal dynamics and what resources (if any) they would leverage? There were consistent responses from the participants regarding the project being a temporal engagement that would not necessitate involving external resources such as a professor or mediator. One participant stated that they would "try to manage the tension between team members, but primarily focus on getting the project done so that everyone can leave each other alone." Most participants discussed mitigating the behaviors internally among the team members, if there was an action taken at all. There was also a noteworthy finding from three participants who did not detect any of the bias events. They made distinctions between a school environment and a professional working environment. For example, one participant stated:

> "Well the guy on the right [Ethan], just thinking that he knows best, and then nobody necessarily speaking up because they're like, okay…[*sic*] well, we don't

> have that much more to go on this project. It's not worth bringing up, or it's not worth trying to confront the guy in the middle of a meeting, maybe doing it individually afterward."

There was this impression among the participants that there were lower stakes involved with a school project, and addressing bias behavior isn't as emergent or significant with project groups for a class versus in a professional setting. Another participant stated:

> "So, when I think about it, if they weren't necessarily in like [*sic*] a school setting, but in a real work setting. If the manager happened to walk by and hear this conversation he would have the responsibility of ensuring that that type of respect in the workplace is ensured. Making sure that he (the perpetrator) doesn't communicate like that would be important both for the group and for the manager, because how those people act reflects on him (the manager), more than how the people in the group and the way they act reflects on each other. They're kind of all individuals when they're in the group. But somebody who's responsible for them I think, would have a little bit more of a problem with how that's (the bias events) going on."

According to this participant, there wasn't a notion that anyone in the project group had the responsibility to redirect the behavior (negative or bias) in a school setting. Instead, it would be the manager's responsibility in a professional setting to address the behavior. Thus, these repetitive events of subtle gender bias remain in the environment if no one has the intuition to think they're necessary to address or the don't understand their impact on the women over time. Although asking participants what hindered them from taking action on gender biases was beyond the scope of this study, Haynes-Baratz and colleagues (2022) found that participants discussed factors such as the ambiguous

nature of MA, not being trained, and a lack of knowledge on how to take action as reasons that caused inaction.

Discussion

Overall analysis of participants' responses to exposure to five different events of subtle gender bias in a STEM educational teamwork setting revealed that interpretations among white cis-gendered men are mixed. The most recognized gender bias was the "mansplain" event, for which participants were able to readily define a term for this behavior and/or provide examples of how it manifests in interactions between men and women. The "interrupt/talking over" event and the "hepeat" event were also seen as highly negative but were rarely identified as related to gender bias. The remaining events, "note-taking" and "questioning competence", were more subtle expressions of gender bias and were more often missed, viewed as positive, or viewed as negative due to the behavior of the target's reaction (victim-blaming). These results are consistent with results of white men in Studies 1 and 2 (see Table 26), where 90% or more of the participants in both studies had no recognition of the "note-taking" event. In the "questioning competence" event, 88% or more of the participants in both studies had no recognition of the bias.

When comparing the results of the white men participants from Studies 1 and 2, mansplain was also the top detected bias behavior in participants from Study 2. However, mansplain was the third highest recognized bias in Study 1.

Table 26

Numbers of White Men Participants in Bias Condition in Studies 1 and 2 Who Recognized and Labeled Bias Events

Event	Study 1			Study 2		
	No Recognition n (%)	Recognized, no bias n (%)	Recognized, bias n (%)	No Recognition n (%)	Recognized, no bias n (%)	Recognized, bias n (%)
1: note-taking	53 (90%)	2 (3%)	4 (7%)	78 (96%)	1 (1%)	2 (2%)
2: hepeat	33 (56%)	2 (3%)	24 (41%)	64 (79%)	9 (11%)	8(10%)
3: interrupt/ talking over	17 (29%)	9 (15%)	33 (56%)	39(48%)	27 (33%)	15 (19%)
4: questioning competence	52 (88%)	4 (7%)	3 (5%)	72 (89%)	3 (4%)	6(7%)
5: mansplain	35 (59%)	1 (2%)	23 (39%)	55 (68%)	6 (7%)	20 (25%)
Overall: at least 1 event	6 (27%)	7 (12%)	46 (78%)	12 (15%)	32 (40%)	37 (46%)

Note: Study 1: n = 59 white men; Study 2: n = 81 white men

It is important to note that Study 1 was conducted at a different institution from Studies 2 and 3 and may be a contributing factor to the differences in detection. While all of the participants in Study 3 described at least two of the events as negative, only 9 (47%) participants recognized at least one of the events as gender bias when compared to 78% of the white men in Study 1 and 46% of the men in Study 2 observed at least 1 event.

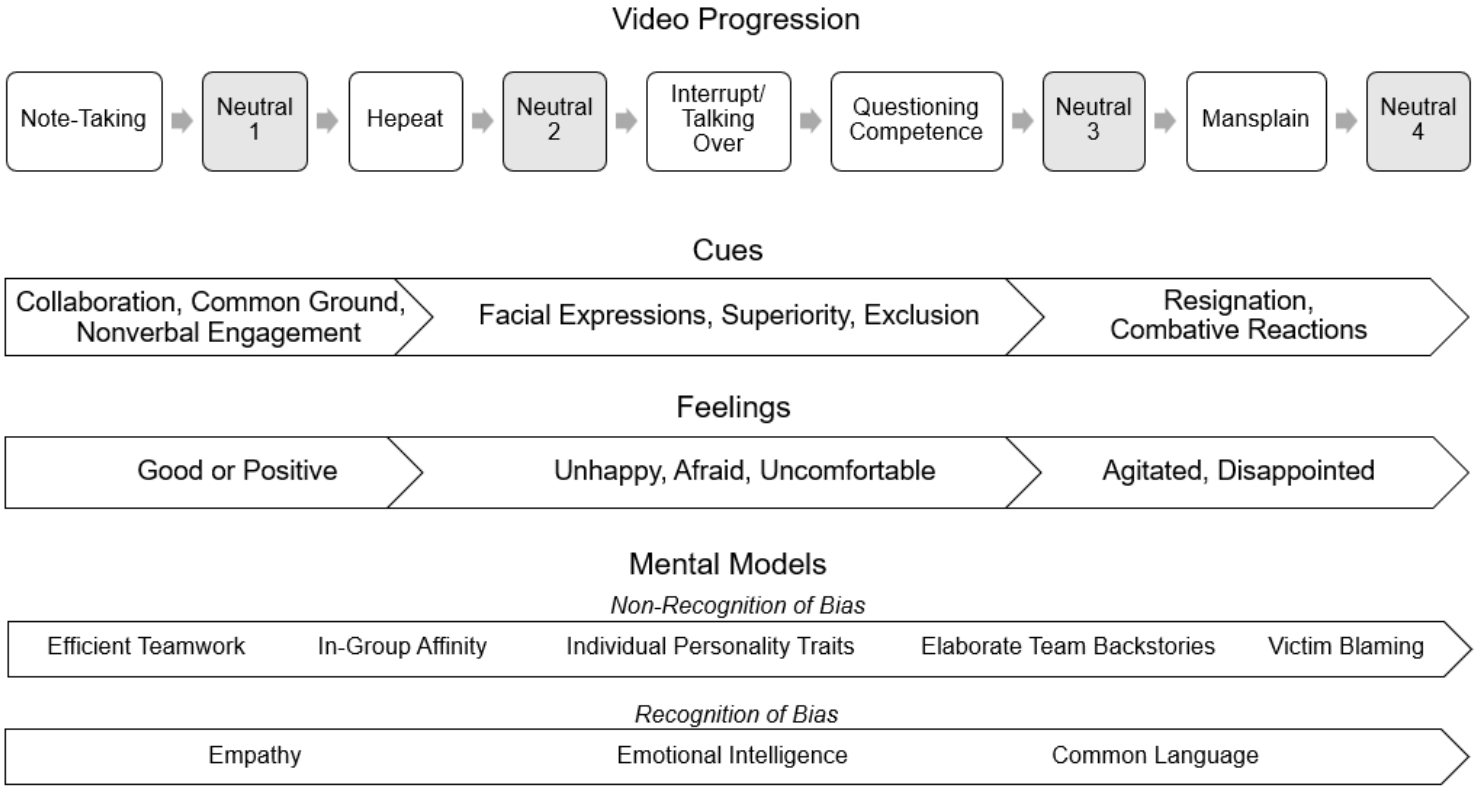
Video Progression Map

The narratives provide interesting insights into individual interpretations of the events as they unfolded in the video as well as how participants attended to cues, felt in response to these cues, and applied mental models to explain the situations that they observed. When taken as a whole, the interviews revealed convergence among the participants in how they navigated the events of the video. Figure 13 offers a visual representation of 1) the progression of 9 scenes of the videos, 2) the progression of

dominant cues as that were detected by participants, 3) the progression of dominant feelings as expressed by participants, and 4) the mental models articulated by participants when bias events were not detected, as well as when bias events were detected. During the first few scenes of the video participants noticed cues related to the team being collaborative and engaging in small talk. Although a majority of participants identified the “note-taking” interaction as a negative interaction, primarily due to the reluctance of team members to take on this non-technical task, they typically perceived within the first two scenes of the video that the team was establishing a common ground. Overall, the participants reported feeling relatively good and positive about the team and the team members’ performance in the early scenes. They observed that the team engaged in lighthearted banter and their mental model was a perception that the team was generally working well together and performing efficiently.

Figure 13

Visual Progression Representation of Video, Participant Cues, Feelings, and Mental Models



Note: The video scenes shaded in gray represent the neutral scenes of the video. The bias scenes are in white.

As the video narrative unfolds, the team in the video demonstrated additional negative behaviors. Participants attuned to some of the subtle cues as they developed a narrative about the team and individuals within the team. There is a shift in the perceived efficient teamwork of positive small talk to observations of team members such as pairing-up, eye rolls, and questioning/challenging one another's ideas. Gender disrespect manifests in subtle yet impactful ways, creating communication breakdowns that inhibit full participation of team members. The participants' feelings then take a turn toward unhappiness, sympathy, and identifying with team members in the video as participants reconcile how they feel about their observations. The dominant mental model of in-group affinity (exclusion of women, and lack of respect) evolves as events of bias become more apparent. Within this sense of in-group affinity, there exists a potential for unintentional exclusion and inadvertent creation of boundaries that isolated certain individuals on the team. The insights of the participants regarding in-group affinity underpin how power dynamics and isolation will shape the trajectory of the team. It sheds light on how gender-based adversity can persist within project teams and go unchecked, while potentially causing a silent, yet long-term impact on those who experience subtle gender bias on a repetitive basis.

By the midpoint of the video, participants notice cues such as being surprised and complimentary of the competency of a woman within the team, dismissiveness, facial expressions (such as raised eyebrows), and no one intervening on behalf of the target. Participants viewed withdrawal responses as coping mechanisms designed to navigate the complexities of a tense team situation. They expressed feelings of disappointment, frustration, annoyance, as well as still being hopeful that the perpetrator(s) will turn their behavior around. There were also observations associated

with team members pushing through (or past) the recognized behaviors in the interest of getting the project done. At this point, participants begin to rationalize what they perceive as negative behaviors through mental models related to victim blaming and highlighting personality shortcomings of team members (primarily the perpetrator(s)) that contribute to their behaviors as opposed to recognizing subtle gender bias events. Some participants discussed an accommodation for the negative behavior by mentioning the unintentionality of the perpetrator(s) of bias. As technically minded individuals, the participants had the tendency to prioritize the team finishing the project over feelings and EQ. For example, one participant mentioned that "the best course of action can sometimes be to finish the project so we can leave each other alone. When bias was detected in these scenes, participants discussed mental models related to a lack of EQ and empathy on behalf of the perpetrator(s) as well as directly naming the "interrupt/talking over" bias event, which was the second highest detected event by participants.

By the last few scenes of the video participants notice cues such as disengaged team members, the low posture (non-verbal body language) of members of the team, and members of the team shutting down. They expressed observing that there were team members who were fatigued as a result of the negative interactions, even when they didn't recognize the negative behaviors as bias, which is indicative of the accumulated effect of subtle bias events. They expressed feelings of unease, agitation, anger and put-off by the behaviors of certain team members. Participants continued to rationalize what they perceive as negative behaviors through mental models related to the personality traits of the perpetrator(s) and began to express elaborate backstories as explanations or justifications for the bias events. The participant's unconscious beliefs,

assumptions, and bias represent how these elaborate explanations can draw unmerited conclusions during their observations. These elaborate explanations provide a poignant danger related to the nature of how subtle gender bias behaviors result in an array of interpretations by a majority population, and ultimately impact individuals personally and collectively as a team. When bias was detected in the final scenes, participants continued mental models related to a lack of EQ and empathy on behalf of the perpetrator(s) and directly named the “mansplain” bias event, which was the highest detected event by participants. It is also important to note that some of the participants who identified the mansplain event as biased still attributed the cause to the perpetrator's motives, such as trying to gain social credibility or wanting to be perceived as smart/competent.

Understanding how the participants progressed throughout the video from start to finish provided me with clarity on how their mental model of the team’s interactions as well as their impressions of individual team members evolved over time. Although participants didn’t always detect the negative behavior as bias, they were able to observe and articulate the impact of the accumulated effect of bias events, occasionally on the women, but primarily on the team as a whole. The in-group affinity mental model for example demonstrated how dismissiveness and excluding others cause targets to become resigned, hesitant to respond, and feel ignored by the end of the video. Thus, participants can see the effect and not the cause of the behavior. Those who see the effect early might go looking for a cause. Instead of bias recognition, they construct elaborate backstories to explain their observations. These are all by-products of the subtle gender bias events that are happening, even when it isn't labeled that way. There was a strong focus on the behavior of individuals of the team, rather than system-level

bias. What began as seemingly neutral and objective observations progressed into strong reactions and feelings toward the behaviors of various characters in the video, especially when disruptive behaviors were displayed. For some participants, their adverse feelings toward the team escalated as the bias events accumulated. What's important to note is how participants perceived that by the end of the video there were team members who had shut down and were fatigued by the behavior of the perpetrator(s) in the video. Participants therefore neglected the concept that, in aggregate, individual bias events become systemic, and attributed behaviors to in-group affinity and the effects of out-group blame.

Barriers to Recognition

Tendency to Accommodate In-Group Members

A process participants used to accommodate the perpetrator was the application of in-group affinity. This happens when individuals have an inherent tendency to identify with those who have similar identities/perspective/experiences, or because they have challenges with evaluating individuals from a different identity/perspective (Heidari et al., 2023). As participants offered explanations or justifications for their observations there was a tendency to accommodate negative behavior especially among in-group members (men) and apply victim blaming for out-group members (women), consequently reinforcing gender biases in the environment. While accommodating in-group members, participants who detected negative interactions, but not bias, often discussed intentionality and made points to clarify that no harm was intended in the perpetrator's actions. Participants leveraged the individual personality traits of the perpetrator(s) as a reason for these negative interactions. Personality traits descriptions such as well-intentioned, lack of awareness, unconscious, threat, and unintentional were among

some of the words participants used. These justifications made room for the behavior while still offering a consideration for negative behaviors. Dr. Peggy McIntosh addresses the unseen dimensions of a majority population and refers to unacknowledged male privilege as a phenomenon of white privilege (McIntosh, 1989). She discusses privilege as an “invisible weightless knapsack of special provisions, maps, passports, codebooks, visas, clothes, tools and blank checks” (McIntosh, 1989, p.1). McIntosh’s contribution speaks to participants in this study having a tendency to accommodate the behaviors they witnessed as the notion of societal stereotypes were potentially invisible to them. There was a tendency to acknowledge the fact that the perpetrator wasn’t intentionally being hurtful, and they are behaving in this way because it’s their personality, rather than acting purposefully in a negative way or being influenced by sexist or stereotypical attitudes. No harm (unintentionally) gets at a root definition of subtle gender bias, but what is ignored is how these seemingly harmless actions give the perpetrator a pass on how the slights impact the target (especially over time). Thus, there wasn’t an overall connection between the unintentional, yet dangerously impactful events of subtle gender biases. Participants also described elaborate backstories for the negative behaviors they witnessed in the video. When directly asked why they interpreted the interactions as positive or negative participants, wanting to answer the questions as they were posed, would occasionally reach for explanations for the behavior of the perpetrator(s). This occurred whether participants detected bias, when they viewed the behavior as a negative interaction, and even when they viewed the behavior as a positive interaction. This tendency is in alignment with social identity theory. Derived from researchers in the 1970’s, the theory proposed that people formulate a piece of their self-identity from their in-group memberships (Tajfel & Turner, 1979). The theory crystallizes the participants'

natural inclination to deem peers who look like them in a positive light, thus subconsciously boosting their own self-image.

Tendency to Blame Out-Group Members

As previously mentioned, events of victim blaming occurred when the behavior of the target was attended to outside of the context of biased or rude behavior on the part of the perpetrator. In the eyes of the participants, they observed cues (reactions) of the targets were unmerited, baffling, and occasionally resulted in an unfavorable or negative interaction for the team. Participants were found holding the targeted individuals accountable and objectively blaming them for negative interactions (Johnson et al., 2021). For example, several of the participants did not understand why the target responded negatively (most often through non-verbal cues) when they were confronted with bias. For most of the events of subtle gender bias, they are blind to an out-group observer (witness) who may not experience bias in the same way, and at the consistency that a target would (Haynes-Baratz et al., 2022). Participants noticed bad behavior but may not have the contextual knowledge of subtle gender bias to make a connection to the behaviors they are witnessing. In alignment with research on modern prejudice, majority individuals are commonly not aware of how their behaviors are rooted in systematic biases (Perry et al., 2015). One of the dangers of victim blaming is the threat of undermining a collective group of individuals for an individual behavior. For example, in the “note-taking” event there is an underlying assumption that women have better handwriting and thus should be the individuals who take the written notes in mixed-gender teams. However, when women engage in these activities, they may have less opportunity to participate in the technical aspects of the team discussion while they record them (Meadows & Sekaquaptewa, 2013). For an individual who is unaware of this

pervasive assumption and its negative influence on participation, it may be difficult to understand why somebody might take issue with taking notes. Thus, the adverse response (verbal or non-verbal) by the target can be baffling and interpreted as excessive and unnecessary. Consequently, from the perspective of the witness (participant), the target's credibility is diminished as well as their perceived ability to be a collaborative and a valued contributor of the team. In both the tendency to accommodate in-group members and the tendency to blame out-group members, participants often referred to individual traits instead of systemic reasons for the subtle gender bias events. When the participants were probed (required) to give reasons why they identified the team interactions as positive or negative they often resorted to faulty inferences about individual group members. This type of response is called fundamental attribution error, defined as applying internal attributions and cognitive bias to rationalize one's personality or disposition as contributors of the behaviors they observe, rather than the systematic social or environmental forces at play within the environment (Ross, 1977).

Cumulative Impact of Negative Events

As reflected during the video progression discussion, participants were able to tangibly observe and discuss how the repetitive behaviors of the perpetrator(s) progressively affected the team. They noticed how Ethan's superiority personality traits lead to a sense of resignation, fatigue, and withdrawal among the rest of the team members. A participant commented on how Ethan repeatedly cut off team members:

> "I know if that action was repeated over and over and over again. I know I definitely would probably stop contributing…So I would assume that those actions probably have continued on beforehand, and that led to them (the rest of the team) not wanting to contribute a lot."

Participants were able to detect how negative interactions impacted the team over time, but not how it impacted the women during the team meeting and certainly not over time within the STEM educational environment. Lundeberg (1997) found that students have the tendency to disregard the notion of subtle gender biases during interactions between peers within the classroom. So, a focus on the exhaustion of the team as a whole overshadowed how the women were affected by these biases, and the dangerous cumulative impact they have on the women's biological, physical, emotional, cognitive and behavioral well-being over time; and reinforcing what Hall & Sandler (1982) refers to as a chilly climate for the women on the team.

The Importance of Context

Several participants acknowledged that they'd be more prone to address the negative behaviors that they witnessed if they were in a professional work setting instead of a college group project. They felt as though there's more at stake in a longer-term work environment versus a temporary academic project team that will conclude at the end of a semester. This perspective speaks to the lack of awareness of the systematic nature of gender bias. Even when participants acknowledge that the observed behavior is negative, they tend to treat each incident in isolation without an acknowledgement that the targets experienced multiple negative behaviors or had potentially experienced consistent and repetitive bias experiences throughout their academic STEM career. Thus, participants demonstrated no clear understanding of the

deleterious outcomes associated with the accumulated effects of gender bias from a physical, emotional, and mental health standpoint. Several participants also exhibited the tendency to pass along the responsibility of confronting subtle gender bias events to someone with authority in the setting. As mentioned previously, a participant saw this as the responsibility of a manager in a professional setting without considering that he could take the initiative to address the climate of the project team. There was also the impression that a manager is better equipped to address the bias than the participant. This propensity to delegate decisions or 'pass the buck" is consistent with research from Steffel and colleagues (2016) who found that people tend to delegate choices when these decisions are perceived to be associated with negative consequences. They found that individuals prefer to not have the burden of being held responsible or blamed if the outcomes of holding others accountable are not in their favor or when it doesn't affect them personally. Furthermore, social identity theory could be attributed to the trepidation to hold in-group peers accountable as students aim to be socially accepted and do not want to appear as intervening or being personally responsible for helping the victim (Tajfel & Turner, 1979). If white men feel that there is no need to address subtle bias (or even negative behavior) in an academic teamwork setting, they are once again ignoring or ignorant to the cumulative impact of this type of behavior on both men and women in this environment. The findings of Study 2 demonstrated that women won't even have enthusiasm for joining project teams when these events are present, and because this behavior is particularly deleterious to women, the impact of repetitive subtle bias interactions are potentially leading to the attrition of women studying in STEM fields before they even get to experience a professional setting where subtle bias events persist.

Contributors of Recognition

Three overarching mental models resulted in participants' ability to detect subtle gender bias when witnessed. The three themes were, having common language to label the bias behavior, EQ, and empathy.

Common Language

Of the five subtle bias events, “mansplain” was the most detected bias event. It was also the bias behavior where participants recognized it by using the words “mansplain” or “mansplaining” which they were readily able to accurately define when asked by the researchers. The participants often rattled off these words as if they were frequently used and/or understood. They attached words such as “classic” and “common” as descriptors, indicating that it is a common phrase that is colloquially used by their peers (or age-group). “Mansplain” for example became viral as a result of Rebecca Solnit’s (2008) published essay titled “Men Who Explain Things” in an online blog in 2008, discussing the harm that this particular form of condescension has for women. The essay was also published in the Los Angeles Times that same year. That catapulted in “mansplainer” being named one of The New York Times’ 2010 (Sifton & Barrett, 2010) words of the year. Rebecca published the book “Men Explain Things to Me” in 2014 and by the time, the term was already viral on Urban Dictionary as of 2009.

Once mansplain (-er, -ing) hit mainstream it became common vernacular to describe a subtle gender bias event. "Hepeat(-ed)" had a similar journey, it went viral in a tweet in 2017 by friends of US physics professor and astronomer Nicole Gugliucci. “Hepeat” is gaining traction and can be found numerous times in Urban Dictionary; but it has yet to gain the same momentum as “mansplain”, which is now published in the Oxford English Dictionary as of 2018. These (now mainstream) words speak to how men

attempt to leverage power and influence over their targets, perhaps because their ideas feel threatened, versus enriching a conversation through dialogue and discussion with their women counterparts. These words that are now commonly known terminology to define types of bias behavior can aid in one's ability to detect the bias within their environment. Thus, there is power in the naming of a phenomenon and describing it in order to give keys to interpreting it.

Emotional Intelligence and Empathy

Participants' responses suggested that they leveraged EQ and/or empathy as effective mechanisms to recognize bias. Similarly, they were able to detect when the actors displayed a lack of EQ. For example, one participant mentioned "I related to Rachel, I've been there when someone with a pretty loud voice just steam rolled through. I can sympathize with Rachel. I felt bad for her." When this type of perspective taking was at-play, there was a distinction in the participants who had the social awareness to pick-up on verbal and non-verbal cues and be attuned to the presence of gender biased interactions. Those who demonstrated these levels of EQ were able to discuss gender bias calmly and critically think about their observations and not endorse, ignore or perpetuate bias behaviors creating an inclusive environment. This finding is consistent with results of a 2021 study regarding EQ and attentional bias where researchers found that individuals with high-EQ when compared to low, were able to process emotional information and detect complex stimuli related to emotionality more effectively (Fiori & Ortony, 2021). One participant discussed the detrimental effects of the repetitive nature of subtle gender bias. He stated:

> "The reason why she [Erika] fell silent after he stated this explanation (of opportunity cost) is maybe this is just a frequent occurrence and it's just not

worth the fight…maybe in the past trying to do anything in that instance just leads to an argument, or perhaps some tense feelings."

This participant's ability to detect and understand/emote the perspective of the target speaks to his empathy and his ability to draw conclusions related to the corresponding impact of subtle gender bias, such as shutting down, resignation, and fatigue. In contrast to the need for accommodating in-group members, participants who detected bias were less prone to respond defensively when confronted with and recognizing bias in someone who looked like them. They were better able to emotionally disassociate their allegiance to an in-group member and challenge the institutionalized prejudices against women with humility and objectivity. This resulted in taking-on an allyship perspective toward subtle gender bias.

Limitations

This study was conducted utilizing a pre-recording scripted interaction by leveraging actors to enact the desired subtle bias events. Prior research ensured that the biases that were displayed during the video were rooted in ground truth as commonly detected subtle gender bias events in STEM education contexts. Although there are some benefits to having a standardized and consistent scenario for the participants to view, I acknowledge the fact there is a risk of "over" acting and having manufactured responses that may not accurately reflect the nuanced emotions and dynamics of an actual project team. Within all three studies there were participants who addressed the notion that the team members in the video were acting and/or some of the interactions appeared to be artificial. This was more prevalent in Studies 1 and 2, with only two participants mentioning it in Study 3. Nonetheless, artificiality could have influenced the interviews if the participants deemed the interactions of the actors as

unnatural. An additional limitation of the video was the selection of the actors. Three of the actors were majority (white) represented, the fourth presented as an Asian-American woman. This potentially creates a racial and gender intersectionality that could add to the complexity of the participants' observations. Having an actor with multiple marginalized identities can differ from having actors with single identities as they run the risk of having compounded forms of discrimination being at-play in the participants' interpretations and can amplify the effects of bias.

The interviews of this study were conducted virtually via Zoom. Although this may have aided in the believability of the cover story of a pre-recorded project team meeting, it did pose some limitations related to building rapport between the interviewer and participants. There can be an invisible barrier to human-to-human interaction within the virtual environment. I was aware of this risk, and purposefully inserted a few minutes at the beginning of the interview for introductions of the interviewer and participant to build common ground. Although important to note as a limitation, I believe that having the advantage of transitioning into a post COVID-19 learning environment aided in the participant's comfortability to conduct the study via Zoom.

Another limitation of the study was homogeneity of viewpoints as all of the participants were recruited from the same institution. There is a risk that they will produce responses that are congruent with the beliefs and expectations within the university's culture. Thus, they may share similar types of values and/or cultural norms which can restrict the variation of responses and perspectives represented in the study. These factors can have an impact on the ability to draw generalizable conclusions that may not accurately represent the broader population of STEM students. There were some institutional differences of recognition between the three studies of this

dissertation; this gives a reasonable justification for the need to expand this study across multiple institutions as it may reveal more mental models, particularly for recognition and/or non-recognition.

Careful consideration was given to the methodological approaches utilized in this study. The aim of this study was to encapsulate and make sense of the phenomenological lived experiences of majority white male students majoring in STEM utilizing IPA. A limitation and criticism of this approach is whether the participants and researchers have the necessary skill and ability to articulate the nuances of these experiences. Junior and senior level participants were recruited as they were more likely to have experiences with working in project teams and contextual knowledge of these types of interactions. To combat the risk of the nuances, strategies such as a two-phased interview protocol and reflexivity were used to ensure rigor, clarifying questions, and objectivity was incorporated and leveraged during the interview and the interpretation of the participants' narratives. Furthermore, iterative and member checking analyses were used to extrapolate convergent themes, individual narratives, as well as divergent themes. By leveraging these strategies, I attempted to address the nuances of the IPA approach throughout all the phases of the data collection and analyses of this study.

The final limitation of the study was the risk of interview fatigue in the participants and researchers. On average, the interview lasted 1 hour and 11 minutes with the longest interview lasting 2 hours and 25 minutes. Interviews that run too long can lead to a withdrawal of engagement, disinterest, and attention over time. Participants and the interviewer can become tired, hungry, restless, etc. These aspects of the interview process can result in a loss of focus and diminished returns on the interview. As the lead

researcher, it was important to ensure that the participants' time was honored, and expectations were clarified. In the times when the interview was going to go beyond one hour, we took a pause and informed the participants of an estimate of how much additional time is needed to conclude the interview and asked their permission to continue. All but one of the participants was willing and able to complete the entire interview. In spite of their willingness, as a responsible researcher I must consider the participants' autonomy and that they are not stressed by the inconvenience of a lengthy interview. During this study I was not consistent in maintaining the 1-hour interview expectation but attempted to have corrective strategies to regard the participants time and ability to maintain the maximum data quality. In the future it will be important to maintain the time integrity of the interview and have the ability to make adjustments real-time to optimize time spent with each participant.

Future Work

Building upon the work of this study, there are several future directions to consider. Research design considerations could incorporate interviews with individuals from various representations. For example, it could be a valuable insight to replicate this study with participants from marginalized identities (white women, gender identities, and racial identities) to determine their ability to detect these biases. Additionally, as mentioned in the limitations section, expanding the study to include multiple institutions would offer insight to consistencies or inconsistencies in STEM academic settings. In other words, are STEM students the same everywhere in their ability to detect bias, or are the institutional differences based on campus culture, geography, public/private, etc. For example, the detected bias events in Study 1 were different when compared to Studies 2 and 3. An expansion of this work could also consider replication of this study in

various graduate-level STEM programs or a professional STEM work setting to determine if there are subtle gender bias detection differences as the student/professional experiences evolve. Furthermore, facilitating this study in-person or in a focus group setting could provide additional layers of insight and richness to this line of research. Replication could also include exploring other forms of biases such as racial, gender, ageism, beauty, sexuality, etc.

To narrow the scope of this study, all of the interview questions weren't included when these data was analyzed. For example, participants were asked questions such as which individual in the video they spent the most time attending to, who they deemed as the leader of the team and why, etc. Analyzing these questions could explore additional aspects of the mental model of the participants. For example, a compelling addition to this study in the future would be to incorporate eye-tracking technology. Having the ability to understand where the participants fixated their attention and who they attended to during the interactions could provide a rich contribution to behaviors that were potentially missed during the participant's observations. Eye-tracking will also aid in constructing some thematic conclusions related to which individuals were attended to the most, i.e. a target, a perpetrator, the individual with the most talk time, etc.

All of the participants also took the QCAE cognitive empathy instrument prior to their interview. I was able to address results in the individual narratives of four participants but could not conduct any overall statistical analyses with only 19 participants. However, having a way to determine a participant's level of empathy, specifically out-group empathy is worthy of exploration as it may aid majority men in the recognition of subtle gender bias events.

This study addressed the question of “what” participants are seeing while observing subtle gender bias events and how they interpreted what they saw. In other words, are they able to detect the behavior as positive or negative, and would they see it as bias. IPA is similar to other phenomenological research because its aim is to explore the lived experiences of the participants, but this methodology does not give us clarity as to why the phenomenon is happening in this manner. There could be a variety of factors such as power dynamics, gender socialization, personal experiences, as well as historically male-dominated professions contributing to the participants ability to detect or not detect biased events as they witnessed them in the video. Exploring the reasons “why” participants were able (or unable) to detect bias events is certainly of interest but was beyond the scope of this study. Some of the interviews did aid in drawing conclusions of why, but it wasn’t an explicit research question addressed during this study. For example, “why” questions would help in exploring why participants rationalized negative interactions as personality traits (of the perpetrator and the target) instead of systemic bias. Having the “what” and the “why” can aid in the development of interventions and the introduction of new cultural norms for STEM education.

Conclusions

This study explored how college-aged cis-gendered white men who are STEM majors detect and interpret subtle gender bias events during a video observation of a team project meeting in an academic setting. Results of this study offer novel contributions of the cues, feelings, and mental models (sense making) employed by this population in response to witnessing subtle gender bias. Barriers that prevented participants in this study from recognizing bias were in-group accommodation, out-group blame, cumulative impact of negative events, and the context of an educational

environment versus a professional setting. Bias was recognized when majority white men participants in this study leveraged mainstream bias terminology (e.g. mansplain and hepeat) and when they noticed deficiencies in emotional intelligence and empathy on behalf of the perpetrators of bias. These findings are especially important to inform future research and potential interventions on subtle gender bias in STEM.

I leveraged two methodological approaches, CIT and IPA to facilitate the interviews and analysis of the results. CIT supported us in obtaining detailed and rich interpretations from the participants. CIT influenced the design of our interview questions as well as our real-time follow-up questions by gathering firsthand insights of the participants' interpretations of the bias incidents they observed. As a result of leveraging these methodologies, my findings resulted in a deeper contextual understanding of how a white men make sense of subtle gender biases.

Leveraging the IPA methodology and conducting the interviews in Study 3 with a near peer contributed to the richness of the interviews with the 19 participants. IPA afforded the participants and researchers to have elements of rigor and transparency during the interview by focusing on the perspectives of the participants while maintaining neutrality and objectivity as researchers. Having an in-group member conduct the interviews appeared to aid in the comfortability of the participants and their willingness to engage in dialogue, and in some situations, a willingness to extend their interview time to complete the entire study. Also, by utilizing a reflexive diary approach, IPA aided in my ability to reflect in real-time during the interviews without wearing multiple hats such as facilitation and asking additional probing questions. The diary also helped while transcribing and analyzing these data as it facilitated a mechanism to articulate the nuances of my own biases, feelings, and assumptions as they manifested.

Near peer interviewing would be an important consideration during replication of this study. As with this study, Stewart and colleagues (2021) suggested that approaches to intervention that are rooted in problematic assumptions are less effective than gender transformational methodologies (such as changing mindsets and shifting mental models) that engage boys and men in gender equity work. Methodologies such as an interrogation into these areas (i.e. semi-structured interviews in Study 3) provides a novel contribution to a gender transformational approach to understanding the mental models of white cis-gendered men. Thus, expanding Study 3 to other institutions may converge findings and develop generalizable findings across STEM educational programs in the United States.

The bias behaviors displayed during the video are not isolated interactions that happen at a single instance in time (Jones et al., 2016). They create a systemic climate of bias discrimination even among well-intentioned and unconscious perpetrators. There was an element of disconnect to bias events for some of the men in Study 3, as reflected in the barriers to recognition discussed. The systemic aspect of non-detection of bias could be attributed to privilege i.e., they don't have bias experiences, so they can't relate. In other words, they don't know what they haven't experienced systematically. Therefore, they carry an "invisible knapsack", resulting in justifications such as victim blaming and attributing bias behavior to personality traits of the perpetrator, instead of systemic implications. The long-term effects of subtle gender bias are a potential threat to the overall wellbeing of the targeted students, and progressively the targeted professionals in the workplace. Furthermore, there are negative outcomes for non-targeted individuals who witness bias events. All team members whether they are students or working professionals have a responsibility and part to play in remediating

the STEM culture. As allies, or even as targets, there is a motivation to bring awareness of these behaviors to the perpetrators and the implications of their unconscious bias, prior experiences, or the systematic influences of society. This line of research will aid in efforts to transform the academic climate by making it more inclusive and welcoming to women and individuals who are marginalized within the STEM academic climate.

Chapter 5 ~ General Discussion

The contribution of this body of work relates to understanding how witnesses recognize subtle gender bias in a STEM undergraduate context, as well as the implications and influences of this recognition on important outcomes for the witnesses. The novel contribution of this dissertation involved an exploration of approaches to detect and disrupt the cyclic negative impact of subtle gender bias.

Findings of Study 1 resulted in a conceptual model suggesting that simply witnessing subtle gender bias events can increase conscious endorsement of gender stereotypic beliefs for both men and women. Those who witness bias and do not recognize it as stereotyping appear to have stereotypes activated which leads to greater explicit endorsement of stereotypes compared to those who recognized and identified the bias of did not witness bias. Thus, recognition of bias potentially serves the role of disrupting a recursive process allowing the propagation of STEM gender stereotypes, degradation of the climate for women in STEM, and negative outcomes for all involved who are present in these settings. These findings highlight the importance of being able to recognize subtle bias events as stereotyping, even as a witness, since it is likely that more people witness subtle bias in workplace and academic settings every day than are direct targets of bias themselves. Study 1 also demonstrated that women are recognizing bias events at a higher percentage than men.

Study 2 advanced understanding of the influence of subtle gender bias on performance and persistence in STEM. It supported the findings of Study 1 by also demonstrating that women are recognizing bias events at a higher percentage than men. Because fewer men recognized bias (less than half – 45%), the ability to act on reduced explicit stereotype endorsement falls to a smaller group of majority

individuals. Additionally, when women detected gender bias in the environment, they were less enthused about engaging in teamwork with the team they observed in the video. Interestingly, women's performance on a spatial ability test was not negatively influenced by witnessing/recognizing subtle gender bias. Nonetheless, women may experience pressure to conform to these biases especially if they are the only ones recognizing them and/or there aren't bystanders who are also recognizing and addressing the behavior among their in-group peers. However, when subtle gender bias is recognized and addresses by majority population individuals it can potentially create empowering environments where women in STEM can actively participate, excel, and optimally perform. Therefore, it is important to understand the mechanisms by which majority men might recognize (or not recognize) subtle gender bias events.

As a result of the conditions of the team interactions, Study 2's findings demonstrated that participants in the control condition reported greater enthusiasm for the team they observed than did those in to the bias condition. These findings are similarly aligned with a previously mentioned 2019 (Pietri et al.) study where participants who witnessed bias behavior had a decrease in sense of belonging. Study 2 also demonstrated that women were not enthusiastic about joining the team they observed when they were able to detect subtle bias events as gender stereotyping

Based on the findings of Studies 1 and 2, Study 3 explored how majority men made sense of subtle bias events as they watched bias events unfold during a 5-minute video of a STEM project team. Study 3 addressed the recommendations of Basford and colleagues (2013), that more information is needed about why men aren't detecting gender discrimination. They suggested that prior experiences with discrimination, empathy, and understanding cues (such as facial expressions and inattention) to

detection are mitigating approaches worth exploring. Study 3's findings related to the cues, feelings, and mental models (sense making) employed by this population in response to witnessing subtle gender bias events provided novel contributions towards understanding these phenomena of bias detection on our road to viable interventions, training, and best practices in STEM education. Participants were able to successfully detect bias events by utilizing stereotype defying behaviors, skills, and/or language. For instance, noticing superiority behavior served as a cue for identifying bias through common language/definitions of bias expression (e.g. mansplain). Also, participants who detected bias articulated feelings such as alarm, being uncomfortable, and disappointed as they noticed a lack of empathy or emotional intelligence in the perpetrators. These findings can be used to disrupt the pervasiveness of subtle gender bias within the STEM education environment through specific interventions designed to target this knowledge and these skill sets.

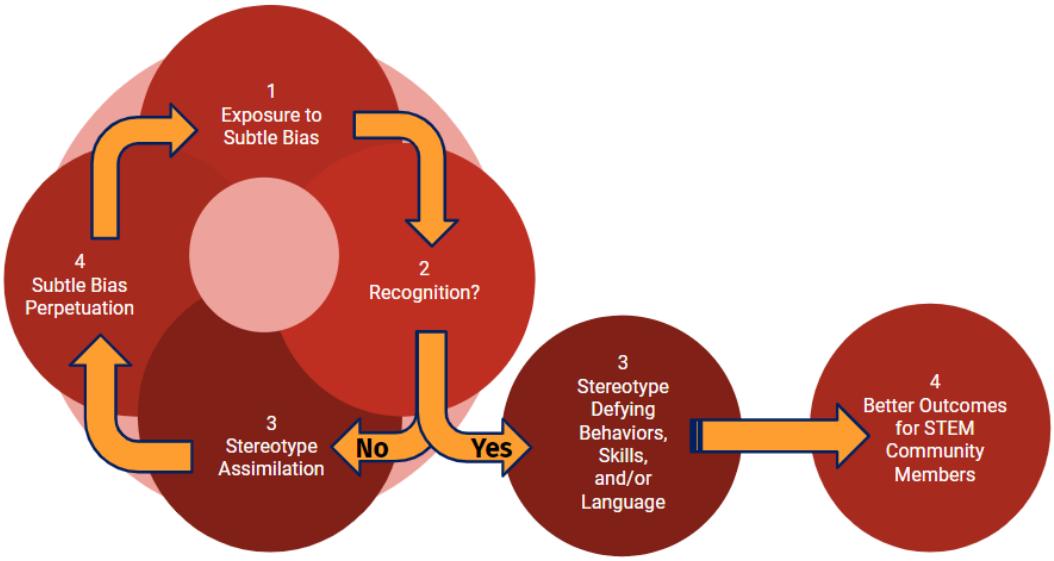
When participants didn't recognize bias, they identified cues related to exclusion to reinforce their sense of in-group affinity, while expressing feelings of confusion as to why the target responded to bias in the way that they did. They often deemed the team interaction as temporary and didn't see the necessity in addressing problematic behaviors that they saw as one-off instances or due to individual personality traits. Nonetheless, even when participants didn't recognize bias, they were able to articulate the accumulated negative impact of the interactions portrayed in the video on the team as opposed to the impact of repetitive bias on the women.

However, when majority men can recognize bias and leverage stereotype defying techniques (e.g. tempering explicit STEM gender stereotypes), the cycle of bias from Figure 14 can be interrupted, which could lead to an improved STEM environments

for both women and men. Thus, this research provides evidence that bias awareness interventions are important because they may increase one's ability to recognize subtle bias as stereotyping, which may reduce future stereotyping in STEM settings.

Figure 14

Interrupting the Cycle of Bias Through Stereotype Defying Behaviors, Skills, and/or Language



Note: When individuals recognize subtle bias events as gender stereotyping and leverage stereotype defying techniques, subtle gender bias can be interrupted in STEM settings.

It is also worth discussing the observations that were made by the participants in Study 3 regarding their detection of the effects of microaggressive stressors as discussed in the literature review. They noticed cues when team members, especially targets, disengaged from the team through verbal and non-verbal responses. These forms of disengagement could lead to emotional microaggressive stress over time. Also, behavioral microaggressive stress could have been salient for targets as a result of the "questioning competence" and "note-taking" bias events. Men in the study often failed to

notice the bias, but noticed the women's responses to it, leading them to blame the victim for negative group behavior. The failure of men to notice and the bias and asking women to take on stereotypical tasks like note taking means that women in STEM may find themselves repeatedly needing to prove that they can offer technical contributions and not just these gender stereotypical tasks..

Having a greater understanding of how gender biases (even in subtle expressions) affect one's ability to work, collaborate, and support others in an academic setting provides valuable insight into the creation of supportive environments for women in STEM. Study 1's conceptual model suggests that there is value in open discourse of the issues of stereotyping and bias in STEM, as individuals learn more about how to recognize bias. Utilizing the model, intervention methods and/or educational tools could be developed by STEM educators and university administrators to provide STEM students with information and resources about how subtle bias is evidenced in STEM settings, which can help them learn to recognize it and avoid it in their own behaviors and choices.

Implications

When subtle gender biases remain present in STEM environments, they become universally infectious to everyone and cancerous to the targets. Both men and women have a propensity to endorse STEM stereotypes when they don't have the knowledge, understanding, language, or willingness to address these detrimental events. The findings of this dissertation showed that STEM project teams riddled with bias become increasingly concerning, causing observers to become less enthusiastic about participating in them. The necessary source to prevent the normalization of subtle gender bias is recognition. There have been efforts related to calling out bias, by holding

individuals accountable for stereotype reinforcements, however this dissertation found that there is a myriad of justifications used to “explain off” the negative interactions instead of acknowledging bias within the environment. Therefore, it is equally important to address the elaborate backstories, in-group accommodations, and victim blaming that are offered as alternative explanations for biased behaviors. When individuals do not have the language, experiences, or points of reference to articulate bias, they are at a loss for rational explanations and resort to mental models that are logical to them. Being mindful that generally individuals don’t intend to harm in subtle bias instances challenges us all to extend some grace and not assume the one should know better because perhaps they simply don’t.

Interventions are also warranted with those who are in positions of influence on college campuses. Carnes et al. (2015) findings demonstrated that gender bias habit reductions interventions are novel approaches to aiding faculty at The University of Wisconsin- Madison to reinforce gender equity at their institution. Additionally, Michigan Tech and other institutions have introduced programs such as *Inclusive STEM Teaching Project*, a 6-week course sponsored by NSF which leverages techniques such as case studies and reflection to train faculty and doctoral students to cultivate inclusive STEM learning environments. Interventions also require institutions to establish sense of belonging as a cultural norm. . A 2019 (Pietri et al.) study found that both women and men had diminished sense of belonging as a result of witnessing biased behavior, consistent with the current findings that enthusiasm was diminished for working with teams where bias was present. Furthermore, best practices can be incorporated into the classroom as well as modeled during administrative, departmental and faculty meetings to circumvent some of the least detected bias events like note-taking. Such as

establishing a culture of rotating the note-taking responsibility within project team. This is one example of a best practices approach that can be taken to gender neutralize the expectation for the women of the team to take-on the task.

Another plausible solution to explore would be initiating catchy phrases associated with bias behaviors that can become viral, especially through social media outlets. The three studies of this dissertation consistently found that mansplain was effectively utilized to call out the bias behavior that participants recognized. For example, the note-taking bias event can be called “she-noting” or “transcript tyranny”, and when these phrases become mainstream language, they can impact homogenous social and professional environments.

This dissertation found that empathy could be a contributing factor to bias recognition. Thus, establishing mechanisms for students to cultivate their emotional intelligence and empathy skillsets in their college curriculum can potentially provide a mechanism for students to move shift their responses toward bias recognition. A 2012 (Daff et al.) study found that employers deem EQ as an important skillset for professional organizations. Furthermore, the *National Association of College and Employers* (NACE) refer to the ability to equitably engage and include others as a career readiness skill necessary for college graduates (National Association of Colleges and Employers, 2022). Thus, incorporating EQ and empathy into general education or accreditation requirements for all students is an advisable recommendation of this dissertation. In general, Participants in Study 3 opted not to address negative behaviors as they didn’t deem them as pertinent enough to address within the project team they observed. There seems to be a disconnect on how these types on interaction impact them as well as their women classmates when they are perpetuated over time.

Assuming that someone else will address these issues requires a call to action to reframe the social interactions in the classroom and during project team experiences as equally important for STEM students and the coursework.

These implications speak to the importance of strategies to interrupt the cumulative impact of subtle gender biases by creating environments where all STEM students can thrive academically, emotionally, and professionally.

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Appendix A ~ Scripts from Studies 1 and 2 Bias and Control Videos

Two video versions were developed, each showing a gender-balanced group of four college students (non-professional student actors) seated around a table similar to the one set up in the lab. The video compilations each showed nine clips. In the microaggression condition, the clips ranged from 15 s to 48 s (total 4 minutes 42 s duration). Five clips showed gendered microaggressions, and the remaining four showed neutral interactions. In the control condition, the clips ranged from 15 s to 45 s (total 4 minutes 39 s duration), and all clips showed neutral interactions (including neutral versions of the microaggression interaction clips and the four neutral interactions; see table below. Video scripts were pre-tested with an independent sample of students to ensure that the microaggression video version was perceived as depicting significantly more gender-STEM stereotyping than the control version, but that the two versions were equal in terms of being realistic and believable as student behavior (pretesting details are presented in the online supplement).

Description of microaggression and control video versions

Clip Number	**Microaggression Version**		**Control Version**
	Stereotypic Interaction	**Stereotype reflected**	**Non-stereotypic Interaction**
1	A man asks a woman to take the secretarial role of note-taker.	Women primarily support men's work in STEM and adopt stereotypic roles such as secretary.	A man volunteers to take notes.
2	Students discuss being in research studies.	None; Neutral interaction	Students discuss being in

			research studies.
3	A woman's idea is ignored until a man repeats it and is given credit for it.	Men are more credible sources of good ideas in STEM than women.	A woman's idea is discussed and accepted.
4	Students discuss their summer vacations.	None; Neutral interaction	Students discuss their summer vacations.
5	A woman volunteers ideas but the men speak over her.	Women's STEM contributions are not as important as men's contributions.	A woman volunteers ideas without being spoken over.
6	A man expresses his surprise that a woman is in a more advanced calculus class than he is in.	It is unusual and unexpected for women to be highly competent in STEM.	A woman states she is in an advanced calculus class without comment from others.
7	Students discuss their internet research.	None; Neutral interaction	Students discuss their internet research.
8	A man explains a concept to a woman after she states that she is already familiar with the concept.	Men have better understanding of STEM concepts than women do.	A man and a woman discuss a concept that they are both familiar with.
9	A woman reads the project instructions and requirements to the group.	None; Neutral interaction	A woman reads the project instructions and requirements to the group.

Note. Clips 2, 4, 7, and 9 were identical in both video versions. Clip 9 provides the engineering-related material that participants were later asked to remember.

Control Video Script

Scene 1

Ethan: Cool, so at our last meeting we established a timeline and now based on that we have to create a design for the rip current sensor so let's get started. So someone needs to take notes.

Ryan: I can do it.

Ethan: Thanks.

Scene 2

Erika: Hey, do any of you remember if we're allowed to look at the camera during this because I've definitely made eye contact with it on a couple occasions.

Ryan: I keep forgetting we're being recorded.

Ethan: A couple of my friends have done studies they say the researchers are pretty laid back.

Rachel: It probably doesn't matter as long as we don't stare at the same time. I'm pretty sure they only care about we what we talk about in the meeting speaking of which, what do we need to talk about?

Scene 3

Ethan: All right, we should start with what color the buoy should be. What do you all think?

Erika: What's a good visible color?

Rachel: Neon orange, how about neon orange?

Ethan: A day glow green?

Erika: What if there was like an algae bloom where the water turns all green?

Ryan: Right yeah, if the water was bright green like that then you-- you wouldn't be able to see it so it should be a color that water never is.

Ethan: Yeah I yeah-- I grew up on a lake that that happens. It gets super green. Um yeah, let's just go with what Rachel said.

Ryan: That works.

Ethan: Neon orange it is.

Scene 4

Erika: So what lake did you grow up on?

Ethan: Oh, my family owns a cabin up north on Bear Lake we go up there every summer and weekends and stuff.

Erika: That's cool we used to go to the UP every summer for a few weeks and room to cabin on the lake. Nice

Scene 5

Ryan: Okay so now, don't we have to have something that'll make it launchable from like 300 feet, yeah? Hmmm... What about like a t-shirt gun? Do t-shirt guns shoot that far?

Erika: Where are we gonna get that? Can you buy one of those at the store?

Ethan: Not sure where you buy one, but they definitely go 300 feet.

Erika: Maybe we can call a sports stadium and see where they get them?

Ryan: You know, I bet you need to use a lot of CO_2 to make it shoot 300 feet.

Rachel: Let’s just research it.

Scene 6

Ryan: So, uh, what do you guys think of calc 2? It's really hard right?

Erika: I didn't think it was so bad just a lot of problem sets... uh so rachel what section of Calc 2 are you in?

Rachel: Oh i'm not in calc 2, i'm in calc 3 with professor Montgomery.

Ryan: Cool.

Scene 7

Rachel: Hey, check this out, you can build your own t-shirt cannon.

Ethan: Oh! It costs less than 100 too.

Erika: Well that might be a good option rather than buying one. The cheapest one I can find is $300.

Ryan: Does it give you instructions on the website?

Rachel: Yeah, I just downloaded a pdf, we can print out later.

Erika: Great, what's next?

Scene 8

Erika: So going back to launching it, I actually have another idea: what about using a remote control boat to pull up to position? I've seen them a lot, even pulling water skiers, and it might be more accurate.

Ryan: That's a neat idea, but do we have enough money for an RC boat?

Ethan: Are you familiar with opportunity cost?

Erika: Yeah, I took an econ class that covered it. An opportunity cost is when you pick one option you're automatically giving up something else by picking up the other options.

Ethan: Right, yeah, exactly and so since our project is like about saving lives in the rip current, we have to choose something super reliable and so then we'll weigh our options of like the cost of an RC boat against the other ideas and like the t-shirt launcher against the reliability.

Ryan: Cool.

Ethan: Yeah.

Scene 9

Ryan: Uh... real quick, could we look at the handout they gave us for the project?

Erika: Oh sure I've got it on the drive, let me pull it up.

Ryan: Thanks.

Erika: So what did you want to look at?

Ryan: Uh... I just want to look at the specs again, make sure we're headed in the right direction on the design.

Erika: Okay so here's what it says: the buoy should hold the GPS tracker face up above the water, the buoy should be launchable from the shore out to a distance of 300 feet, the buoy should have a device hanging beneath it that is designed to catch the current and move the device with the current, the buoy should be brightly colored so it can be seen from a distance of 500 feet.

Ryan: Right, okay, yeah we still need to do something about the device hanging beneath it.

Bias Video Script

Scene 1

Ethan: Cool, so at our last meeting we established the timeline. Now based on that we need to create a design for the rip current sensor, so let's get started. So someone needs to take notes.

Rachel: I can do it.

Ethan: I'd do it but my handwriting is so bad.

Scene 2

Erika: Hey, do any of you remember if we're allowed to look at the camera during this, because I've definitely made eye contact with it on a couple of occasions?

Ryan: I keep forgetting we're being recorded.

Ethan: A couple of my friends have done studies, they say the researchers are pretty laid back.

Rachel: It probably doesn't matter as long as we don't stare at the same time, I'm pretty sure they only care about what we talk about in the meeting speaking of which, what do we need to talk about?

Scene 3

Ethan: Okay let's start with what color the buoy should be. What do y'all think?

Erika: What's a good visible color?

Rachel: Neon orange? How about neon orange?

Ethan: Day-glow green?

Erika: What if there's like an algae bloom where the water turns all green?

Ryan: Right, yeah, if the water was bright green like that then you wouldn't see it, so it has to be a color that water never is.

Ethan: Okay yeah, yeah I grew up on a lake, that does happen water gets super green.

Ryan: Um... well you know how construction workers wear like those neon orange reflective vests?

Ethan: Yeah, neon orange yeah that works uh good one Ryan.

Scene 4

Erika: So what lake did you grow up on?

Ethan: Oh, my family owns a cabin up north on Bear Lake we go up there every summer and weekends and stuff.

Erika: That’s cool we used to go to the up every summer for a few weeks and rent a cabin on the lake.

Ethan: Nice.

Scene 5

Ryan: Okay... so now don't have to have something that'll make it launchable from like 300 feet?

All: Yeah yeah.

Ryan: What about like a t-shirt gun? Would a t-shirt gun shoot that far?

Erika: Where are we going to get—

Ethan: Yeah they definitely shoot 300 feet.

Erika: Okay well I guess you could call---

Ethan: you'd have to have like a lot of co2 to make it go 300 feet.

Rachel: Let's just research it.

Scene 6

Ryan: Uh... so what do you guys think about calc 2? Super hard right?

Erika: I didn't think it was so bad just a lot of problem sets. So Rachel, what section of calc 2 are you in?

Rachel: Oh, i'm not in calc 2 i'm in calc 3 with professor Montgomery.

Ryan: Seriously, you're in calc 3? That's amazing!

Scene 7

Rachel: Hey check this out! You can build your own t-shirt cannon.

Ethan: Oh, it costs less than $100 too.

Erika: Well that might be a good option rather than buying one, the cheapest one i can find is $300.

Ryan: Does it give you instructions on the website yeah?

Rachel: I just downloaded a pdf we can print it out later.

Erika: Great, what's next?

Scene 8

Erika: So, going back to launching it, I actually have another idea: what about using a remote control boat to pull it into position? I've seen it a lot, even pulling water skiers and it might be more accurate.

Ryan: That's a neat idea but do we have enough money for an RC boat?

Ethan: Are you familiar with opportunity costs?

Erika: Yeah, I took an econ class that covered it and---

Ethan: well it's basically like-- it's like if you choose one alternative, than you're giving something up by not choosing the other.

Erika: Yeah I know what---

Ethan: So like since our project is about saving lives in the rip current, it's-- we have to choose something that's like super reliable and then-- so we'll weigh the cost of the RC boat with the other idea and the t-shirt launcher with the reliability.

Ryan: Cool.

Ethan: Yeah?

Scene 9

Ryan: Uh... real quick could we look at the handout they gave us for the project?

Erika: Oh sure, I've got it on the drive, let me pull it up.

Ryan: Thanks.

Erika: So what did you want to look at? Uh... I just want to look at the specs again make sure we're headed in the right direction on the design. Okay so here's what it says: the buoy should hold the GPS tracker face up above the water, the buoy should be launchable from the shore out to a distance of 300 feet, the buoy should have a device hanging beneath it that is designed to catch the current and move the device with the current, the buoy should be brightly colored so it can be seen from a distance of 500 feet.

Ryan: Right, okay, yeah we still need to do something about the device hanging beneath it.

Appendix B ~ Studies 1 and 2 Open-Ended Responses Coding Rubric

Coding Instruction for Open Ended Event Recall

1. Noticing and labeling the five subtle gender bias events shown

There will be two columns for each event, e.g. E1Notice & E1Bias. In each event's "Notice" column, there will be a 0 or a 1. If the participant does not mention the event in any of the three descriptions, place a 0. If they do describe the event, place a 1.

IFF there is a 1 in an event's "Notice" column, you must also fill in the "Bias" column. If the participant's make an explicit mention about stereotypes, gender bias, discrimination, etc., place a 1. If they do not mention gender bias, place a 0.

If there is a 0 in an event's "Notice" column, simply place a - in the "Bias" column.

2. Labeling gender bias generally

If the participants do not explicitly mention an event, but DO mention gender bias, stereotyping, discrimination, etc., place a 1 in the GenBias column.

If they do not mention bias at all within their video descriptions, place a 0.

Supplemental Coding Instructions

1. Affect

The "Affect" column measures the overall positivity – negativity of the described social interaction. Affect does NOT refer to efficiency (i.e. "They were on task and worked well together" is neutral). If a participant describes the video interactions, in any number of the description boxes, as negative, place a 1.

Negative Examples:

"No one said anything to the man on the right about his rudeness."

"This video made me upset for the girls!"

If the participant does not mention the social interactions in the video or describes it neutrally, place a 2. NOTE: Nervousness in and of itself is a neutral affective response.

Neutral Examples:

"The man's deep voice on the left."

“How the team seemed nervous when speaking about the camera.”

“They kept getting off task”

“That three of the participants had mac books”

If the participant describes the interactions as positive, place a 3.

Positive Examples:

“I think they showed great respect towards one another. They seemed cooperative.”

“How well they seemed to get along.”

If the participants describe the video interactions as BOTH positive and negative within their description boxes, place a 2M.

Mixed Examples:

“The guy on the right seemed to not listen to the women,” AND, “The other 3 people seemed to work well together and listen to one another”

2. Scripted

In the “Script” column, place a 1 if the participant mentions a script or describes the interaction as forced.

If the participant does not mention a script or describes the interaction as forced, place a 0.

3. Other

If the provided description is entirely irrelevant to the video, simply fill the columns with a - or leave them blank.

Examples:

“Yes, you need to write a thank you email after an interview if you want to ... Company Spotlight Videos · Industry Spotlight Videos · Employer Resources ... Here are a couple example thank you notes you can use to build your own perfect letter. ... To stand out from the crowd, get more specific with your thank you note.”

“STUDY OF HISTORY”

“It was exciting to be able to apply certain concepts learned in the course to an actual work assignment I was doing at the time. The ability to apply one concept in the "real world" encouraged me to look for ways to incorporate the other concepts learned.”

Additional Notes

Please make note of any responses that you are unsure of or on the fence about here so that we can talk about them when we meet. If you could include a small note about your reasoning for your final decision, that would be tubular.

MICROAGGRESSION/BIAS EVENTS

Event	Example
Event 1: Woman in orange assigned note-taking role; man’s handwriting is “so bad.”	Right away when the guy on the left mentions that someone needs to take notes, he looks at the two girls and expects one of them to offer.
Event 2: Hepeating. Men ignore woman in orange’s idea but accept it when man on left repeats it later.	When the girl on the right suggested bright orange, the guy kind of brushed it off and suggested lime green instead of acknowledging her suggestion.
Event 3: Manterrupting. Man on right repeatedly interrupts the woman in black.	The male on the right constantly talked over the females and didn't listen to ideas they brought forward.
Event 4: Man on left is surprised that woman in orange is in Calc 3 while he’s only in Calc 2.	The boys acted shocked that the girl was in calc 3, like they just have to be smarter then her.
Event 5: Mansplaining. Man on right overexplains “opportunity cost,” interrupting woman in black when she says she already knows what it is.	the one guy completely mansplained the term to the woman. She clearly knew what it was from a previous class. and he kept interrupting her

Coding Methods

There were five events, and for each event there was a “notice” column for if the participant mentioned the event in their response and a “bias” column for if the participant noted that even being negatively influenced by bias. Coders assigned a “1” for participant responses that noticed the event or mentioned bias, and a “0” for participant responses that did not notice the event or bias. Additionally, coders assigned a “1” to the “GenBias” column if the participant mentioned bias at any point and “0” if not, and they also assigned a “1” to the “scripted” column if the participant mentioned the interaction seeming forced or scripted. For the “Affect” column, coders assigned a “1” if the participant reported that the social aspects of the interaction were negative, a “2” for neutral, a “3” for positive, and “2M” if the participant mentioned both positive and negative aspects of the social interaction.

Appendix C ~ Study 3 Interview Script

Welcome to the study. Please ensure that you are in a quiet space and able to focus for the duration of the study. We will get started shortly…

Pre Study Checklist

- All researchers should arrive 15 minutes before the session.
- Be sure to create a waiting room in Zoom
- Change the researcher's Name in Zoom
- Double check that we have consent forms completed for the participant. If they do not have a complete consent form, take time now to allow them to complete it.
- Change their name to their participant number as indicated on the "Study 3 Scheduled Interviews" spreadsheet, but continue to refer to them by their name

Start of Script:

Hello and welcome! My name is Drew and I am a research assistant at the Cognitive and Learning Science Department here at Michigan Tech, and I will be running today's session. This project is related to previous research from a National Science Foundation grant. For your reference, I do have an additional researcher present here in the room to assist me with the interview, but they will remain off-camera and simply ensure that I maintain the consistency standards of the study. You will also notice that I have changed your name to a participant ID number in an effort to anonymously track this interview.

You had a chance to read over the consent form and agree to your participation prior to your session today. Do you have any questions related to this consent to participate?

(Answer Possible Questions)

Also, when you signed the consent form you agreed to allow us to video record the session, is that still the case?

(Answer Possible Questions)

Are you familiar with how to navigate Zoom? Since it will just be the two of us, there is no need to mute yourself as we will be in communication for the duration of our time together. You will not need to utilize any functions, but if you need any assistance, please let me know. Also, if you need a break at any time during this session, just let me know.

Ok, the aim of this study is to observe a working team interaction and provide feedback regarding their team dynamics. As a reminder, this is a semi-structured interview that should only last an hour. During the first part of the session, you will watch a previously recorded team interaction as they are working on their project. As you are watching, I

ask that you tell me to pause the video anytime you see a positive or negative interaction between the team members. To clarify, a positive interaction is a behavior you would complement the individual or group on and a negative interaction is a behavior you would want to address with the individual or group. I will ask you a few questions about what you observed and then we will resume the video until you observe the next positive or negative interaction. The video is short, approximately 5 minutes in length, but for the sake of time we will only play the video once.

After we've completed the stop/start portion of the interview we will proceed to part 2 of the interview. During this part, I will ask you a few additional questions related to your overall impressions to obtain a better understanding of your holistic and group-level impressions of the team. Are there any questions?

(Answer Questions)

Before we get started, let's do quick introductions…

(Interviewer does a brief introduction of themselves, i.e. hometown, major, job, etc.)

Ok, tell me a little bit about you?

(Participant shares)

Thanks so much for sharing! I am now going to start the recording and share my screen to project the video that you will view.

(Researcher will hit the record button in Zoom & share screen. Copy the Email addresses into the chat)

Are you able to see the video projected? Before I hit play, please let me know if the timing on the video is off or if the video is skipping as it is important for you to see the video without any distractions.

(If the video is skipping, you can give the participant access to the video in Google Drive using their Michigan Tech email address)

Are you able to see the video projected? Ok, great! I would like you to be in the mindset that you are observing this team specifically to assess the interpersonal dynamics and offer some feedback. As a reminder, tell me to stop the video anytime you see a positive interaction (a behavior you would complement the individual or group) or a negative interaction (a behavior you would want to address with the individual or group) between the team members. After we discuss the pause, I will resume the video until you observe the next positive or negative interaction.

Any questions before I start the video?

(Answer Questions)

(Begin the video, each time the participant request a stop, the researcher will ask them the following probing questions)

Stop/Start Probes	Intentionality
Why did you stop the video? What did you observe/see/hear? Was this a positive or negative interaction?	Cues
How would you describe this interaction?	Assessment
What were key things that you noticed that lead you to identify this as a (positive/negative) interaction? Was it something that was said or done?	Cues Indications of verbal, non-verbal, empathy, etc.
Why do you think that that person/those individuals behaved that way?	Mental Model
How did the interaction you observed make you feel? Or Did that interaction make you feel a certain way? Or How do you perceive (a particular person) was feeling in this situation?	Emotionality/Empathy

(once you've completed the stop/start portion of the interview, proceed to part 2 of the interview)

Ok, thanks so much for your insight on the video! This has been very helpful. We will now proceed to the second portion of the interview. During this part of the interview I will ask you some additional questions related to your overall impressions of the group as well as particular individuals. Some of these questions may sound familiar to the

previous questions, but they will be important to our understanding and research. Any questions, or are you ready to proceed?

(Answer Questions)

Additional Interview Questions	Intentionality
What were your overall impressions of the interpersonal interactions in the video?	Assessment
What nonverbal cues did you notice, if any?	Cues
Which individual did you spend the most time attending to? (project an image of the team from the video)	Decision Making/Cues
Why that person?	Information/Cues
Who do you view as the leader of the team and why? Were there any shifts in leadership that you observed, and if so, why?	Mental Model for identifying the leader
What did the team do well?	Assessment
What did they do poorly?	Assessment
Did you imagine the possible consequences as a result of the thing they did poorly?	Mental Model

Suppose you were asked to describe the team interaction to someone else. How would you summarize it? What made you draw those conclusions, in other words, what information did you use in making these observations?	Assessment Information
Based on your assessments, How do you envision the next team meeting to proceed?	Mental Model
Imagine that you are a member of this team. What could you have done to improve the interpersonal dynamics of this team?	Decision Making Determine if participants introduce any interventions to the bias behavior. What would their expectations be?
If you were preparing for a future meeting (as if you are a member of the team), what would be your plan or strategy to address better performance in terms of their interpersonal dynamics? What resources (if any) would you leverage?	Guidance Determine if participants introduce any interventions/training to the bias behavior.

Ok, thank you so much for your time and detailed explanations! Do you have any final comments about the overall interactions in the video?

Debrief Script w/ Questions and Compensation

The interview will be ending now, and I will begin our debriefing session to explain the research in more detail. This project was designed to examine how STEM students

notice and interpret subtle gender bias events while observing a collaborative team interaction. In the context of this video we are referring to subtle behaviors that may appear to discount or question women's ability in science or engineering. The video showed a team enacting several instances of subtle bias behavior. The results of this research will be used to aid us in understanding the types of subtle bias events that are commonly detectable; as well as subtle bias events that are not commonly detected. Our goal is to aid universities and future STEM students in circumventing behaviors related to subtle gender bias. I hope that this helps to bring clarity to our interview process, do you have any questions?

(Answer Questions)

If they bring up that they saw the bias after they learn about the study, ask why they didn't bring it up?

Please know that in order for us to examine natural responses to this situation it's important that other people that might be in this experiment don't know the details of this study before they participate, so it would really help us if you do not discuss this experiment with anyone that could potentially be a part of this study, meaning other STEM students on campus! If we get people in the study who already know the intention, we won't be able to get natural reactions and that would invalidate our study. So, please do not share this information with your friends and classmates.

Again, I'd like to assure you that ALL of the information you provided in this study is

confidential and anonymous. Only the researchers will have access to this information in a deidentified format.

As you were informed, your participation in this study is voluntary. If you wish, you may withdraw your participation without penalty, by simply emailing us at ehrstudy email projected on the slide, at which point all records of your participation will be destroyed. If you have any questions or concerns about the study you can email us as well.

If you have questions about your rights, you can contact the Principal Investigator,her contact information is also listed on the slide.

Remember that, you will receive a $20 amazon gift card for your participation in the study. We will send it to you electronically within one week, using your Michigan Tech University email address, please note that it may be located in your spam folder. If you have any difficulties receiving your gift card, feel free to contact us. If you requested course credit instead of the gift card, we will notify your instructor that you have completed the study via email or via Michigan Tech's online Psychology Subject Pool System (SONA). Thank you for your participation, we hope this has been an enjoyable experience for you.

If you have any final questions, I am here to assist. Otherwise, you are free to go and thanks again for your time today!

END OF SCRIPT

Appendix D ~ Study 3 Coding Protocol

Sub Question 1: What cues (verbal & non-verbal) are participants paying attention to?

These questions are highlighted in YELLOW in the script

- What were key things that you noticed that lead you to identify this as a (positive/negative) interaction? Was it something that was said or done?
- What nonverbal cues did you notice, if any?

Positive Cues (in royal blue text) and Negative Cues (in red text) 2 different colors

Verbal (Orange) and Non-verbal (in purple) cues 2 different colors

Sub Question 2: How do these interactions make the participants feel after viewing them?

These questions are highlighted in NEON BLUE in the script

Positive Feelings (in royal blue text) and Negative Feelings (in red text)

Do counts for each participant, then look across participants

Sub Question 3: How do they make sense from viewing the interaction

These questions are highlighted in COLOR in the script

- Why do you think that that person/those individuals behaved that way?
- What were your overall impressions of the interpersonal interactions in the video?

Look for these kind of higher level thinking justification, rationalization, assessment & interpretation of what they say

Appendix E ~ Card Sorting Instructions

Cognitive Task Analysis Class
Card Sorting Task

Instructions: When we try to understand features and cues, one way we can analyze the data is by using a card sorting task. It's a simple task.

As mentioned on the slide deck, the stacks represent cues observed during a 4-person enterprise team project meeting.

Take a few minutes to sort STACK 1 cards into groups (categories) of cards (features, cues) that you think go together. There is no right or wrong answer here.

Once you complete STACK 1, do the same for STACK 2.

After you sort the groups, you will be asked to label or describe the groups. You will be provided with a **data collection sheet** to record your sorted groups.