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A Model of Threatening Academic Environments Predicts Women STEM Majors' Self-Esteem and Engagement in STEM

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Abstract

The present study tested a model of threatening academic environments among a vulnerable population: women in science, technology, engineering, and mathematics (STEM) fields. Women in STEM are underrepresented and more likely to perceive their STEM educational environments as threatening than do men. U.S. Women majoring in STEM fields ($n = 579$) completed a questionnaire measuring each construct of a model of threatening academic environments proposed by Inzlicht et al. (2009). Supporting the model, greater gender stigma consciousness predicted greater gender-based rejection sensitivity. Gender rejection sensitivity predicted more negative perceptions of campus climate. More negative climate predicted more experiences of stereotype threat, which in turn predicted lower perceived control. Lower perceived control predicted greater disengagement from STEM domains, which predicted lower self-esteem. Differences also emerged between women in male- compared to female-dominated STEM subfields and between racial minority and majority women. This model describes how experiences of threatening environments may contribute to the underrepresentation of women in STEM. The model provides an overview for researchers, educators, and practitioners to better understand the relations among hostile STEM climates, experiences of identity threat, and academic disengagement. Interventions addressing environmental and individual factors in the model may improve retention and women's experiences in STEM.

U.S. Women currently earn a larger percentage of bachelor's degrees each year than men do (57%; National Science Foundation [NSF] 2015). Despite years of similar trends, women are still underrepresented in most science, technology, engineering, and mathematics (STEM) fields. Women earned between 47 to 58% of the baccalaureate degrees in biology,

53.9% in agricultural sciences, and 48.3% in chemistry, but fell behind men in other STEM fields including 42.8% in mathematics, 39.6% in astronomy, 38.6% in Earth and atmospheric sciences, 19.8% in engineering, 18.9% in physics, and 18% in computer science (NSF 2015).

Many explanations have been offered to explain this disparity including broad contextual factors such as societal expectations, parental and peer influence, and climate within STEM majors and organizations (Ceci et al. 2009; O'Brien et al. 2016). We propose several factors that create a threatening educational environment for women in STEM and that discourage them from entering and remaining in these fields. Inzlicht et al. (2009); see Fig. 1) proposed a theoretical model of threatening academic environments for targets of prejudice and discrimination. Although Inzlicht and colleagues offered the model broadly for all stigmatized groups in academic environments, their work focused on racial minorities. Here we describe how the model of threatening academic environments applies to women in STEM.

The model predicts that (a) women in STEM are aware of their stigmatized status, and (b) this awareness creates

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Fig. 1 Theoretical model
of threatening
academic environments
(Inzlicht et al. 2009)

uncertainty and vigilance in academic environments in which
their gender is salient (e.g., STEM classrooms). (c) There are
individual differences in whether women are dispositionally
higher or lower in uncertainty and vigilance. (d) Women
higher in uncertainty and vigilance will search their surround-
ings for cues that their gender identity is relevant in that con-
text and may be used in forming judgments about them and
women in STEM. (e) When cues in the environment suggest
gender is not a relevant factor, women typically do not expe-
rience identity threat (termed identity safety). When cues in
the environment, such as the numeric underrepresentation of
women (Murphy et al. 2007), suggest gender is relevant,
women may experience identity threat or worry their gender
will be used against them in judging their suitability for STEM
education and careers. Experiencing identity threat in academ-
ic environments is associated with lower feelings of belonging
(Murphy et al. 2007).

In the present study, we examine stereotype threat, which is
a specific form of social identity threat that is commonly used
to examine negative effects of stereotypes on academic perfor-
mance (Steele et al. 2002b). (f) When women experience iden-
tity threat, this may lead to mechanisms that exacerbate effects
of identity threat, including decreased self-control (Inzlicht et
al. 2006). (g) If the mediating mechanisms facilitate identity
threat, disengagement from and underperformance in academic

domains becomes likely (Lesko and Corpus 2006; Major et al.
1998). (h) Academic disengagement and lower performance
predict effects on the self, including lower self-esteem and
leaving the academic domain (Lesko and Corpus 2006;
Major et al. 1998).

We propose that the model of threatening academic environ-
ments can help explain women's underrepresentation in STEM
fields. Inzlicht and colleagues (2009, p. 20) describe the model
as reflecting a "chain of psychological events" that unfold over
time. The model offers a summarizing framework of existing
stigma research, but it remains theoretical because the complete
model has not been empirically tested in its entirety. The study
described herein empirically examines the model cross-
sectionally using a series of variables corresponding to each
construct to establish the relative fit of the model (see Fig. 1).
Although the current test of the model cannot account for
changes over time, we test proposed mediational models and
alternative models to help establish a potential sequence of
predictors. Further, we extend this theoretical model by testing
similarities and differences in model fit and strength of the
pathways for different populations within STEM, specifically
women in different STEM subfields (e.g., female-dominated
compared to male-dominated) and racial minorities.

This model complements existing work on models of so-
cial identity threat, stress appraisals, and coping (e.g., London

et al. 2014), but we extend this work by investigating multiple mediators of the pathways from experiencing social identity threat to educational and psychological outcomes. Each component in the model and its applicability to relevant subgroups is described next. We present the variable definitions and supporting literature in sections following the order of variables in the theoretical model. We begin with a discussion of awareness of stigma and the social identity threat framework, then we discuss vigilance and uncertainty and individual differences in potentially threatening environments. We follow with a discussion of environmental cues that either confirm or disconfirm potential threat, followed by research on social identity threat, discussion of perceived self-control as a mediator, academic engagement and persistence, and finally effects on self-esteem.

Awareness of Stigma and Social Identity Threat Theory

Social identity threat theory (Steele et al. 2002a, b) proposes that acute and chronic awareness of one's stigmatized identity can lead to heightened vigilance and uncertainty whereby individuals survey their environment for cues that confirm or disconfirm the relevance of their stigmatized status. These cues, whether subtle or blatant, signal the potential for threat, devaluation, exclusion, or discrimination. If cues in an environment confirm the potential for social devaluation, stigmatized group members may experience *social identity threat*—a state of acute stress in which heightened physiological arousal, increased cognitive monitoring, and decreased self-control work together or independently to deplete cognitive resources and subsequently impair performance (Schmader et al. 2008). In contrast, when cues disconfirm the relevance of a stigmatized identity, individuals are likely to experience *identity safety*—a state in which a stigmatized identity is no longer an obstacle for success (Davies et al. 2005). Although awareness of stigma can lead to social identity threat, there are several factors that affect whether individuals experience negative effects of such threat (Schmader et al. 2008), some of which are we describe later. Thus, experiencing social devaluation does not imply that everyone experiences negative outcomes.

A preliminary condition for potentially experiencing social identity threat is awareness of the self as a member of a stigmatized group. Stigma results from societal perceptions that an individual or a group is different from a dominant group within a given society (Goffman 1963). Over time, this perceived difference leads to a negative societal view of the individual or group. Gender, like race and ethnicity, is a marked status that is permanent, not concealable, and uncontrollable (Jones et al. 1984). Pioneering work by Devine (1989) documents that knowledge of negative group stereotypes is widespread, even if individuals do not personally endorse these

stereotypes (see also Amodio 2014; Eberhardt et al. 2004). As a result, we assume that most women are aware of their gender, negative stereotypes about women, and possible associated stigmas when going about their daily lives.

Our study examines women as a stigmatized group within STEM disciplines. Women often are seen as less competent, interested, and motivated in STEM compared to men (Foschi 2009; Heilman 2012). Thus, awareness of stigma within the STEM context is more likely to impact performance and persistence in STEM domains specifically. In addition to variations in awareness of stigma, individuals vary in their sensitivity to monitoring for stigma in various environments; a topic we address in the next section.

Individual Differences in Vigilance and Uncertainty

Although we assume that women are usually mindful of their status as a woman, variance is expected in the degree to which women are aware of gender stigma within society. Indeed, prior research shows a person-group discrepancy in women's perceptions of the prevalence of sexism (Schmitt et al. 2003). Many women admit that sexism is pervasive in society, but fewer women report personally experiencing sexism, often minimizing its impact when it is reported (Foster et al. 2004). Greater awareness of stigma is related to various outcomes including decreased psychological well-being and increased identification with the social group (Schmitt et al. 2002). In our test of the theoretical model, we conceptualize women's awareness of gender stigma as an individual difference variable that serves as a predictor of the subsequent path, detecting environmental cues, described in the next section. Just as women differ on their perceived awareness of stigma, there is variability in their responses to these perceptions, such as perceived control, discussed later.

Gender stigma consciousness is the extent to which women are aware of gender stigma and how often they expect to experience sexism (Crocker and Major 1989; Pinel 2002). Gender stigma consciousness can produce heightened vigilance and sensitivity within one's environment to possible cues indicating one's stigmatized status is relevant. Some sexism remains overt and relatively easy to detect; however, many instances of sexism are subtle and difficult to detect (Logel et al. 2009). Women higher in gender stigma consciousness are more likely to detect subtle threats and attribute them to sexism compared to women lower in gender stigma consciousness (Pinel 1999). Therefore, women higher in gender stigma consciousness are most vulnerable to social identity threat (Brown and Pinel 2003). Greater stigma consciousness is associated with poorer academic (Pinel et al. 2005), mental health (Lewis et al. 2003), and physical health (Hunger and Major 2015) outcomes.

Just like women vary in their consciousness of gender stigma, or the possibility that they may be stigmatized, women also vary in the extent to which they are sensitive to actual or perceived gender-based discrimination or rejection. Women higher in gender rejection sensitivity report greater suspicion that they will be targets of gender-based discrimination (London et al. 2012). This sensitivity is more likely to occur when one's stigmatized status is made salient (e.g., when a woman is the only woman in a class of men; Murphy et al. 2007). Those lower in gender rejection sensitivity are less likely to experience social identity threat and report less prejudice and discrimination (Inzlicht et al. 2008). Individuals higher in gender rejection sensitivity may be more likely to attribute discomfort to sexism rather than to an environmental or interpersonal factor (Wang et al. 2012). Interpreting uncertain or negative environments as sexist can serve a protective function to one's self-esteem rather than interpreting discomfort as due to one's own behavior or personality (Crocker et al. 1991; Major et al. 2003), but research also indicates experiencing sexism can lower self-esteem (Schmitt et al. 2002). Thus, although women STEM students may not experience overt discrimination in their courses or university activities, those highly sensitive to gender-based discrimination are more likely to detect subtle forms of discrimination (e.g., microaggressions) and see ambiguous environments as threatening. Thus, we measure Inzlicht et al.'s (2009) vigilance construct with gender rejection sensitivity (London et al. 2012). We hypothesize that women's gender stigma consciousness will be positively related to gender rejection sensitivity (Hypothesis 1). That is, the more aware women are of gender stigma, the more sensitive they will be to gender-based rejection.

Environmental Cues

In this section, we discuss the types of threatening and safe environmental cues that may be detected among women higher and lower in gender stigma consciousness and gender-based rejection sensitivity. Various environmental cues can signal the potential for discrimination. The absence of environmental cues, or the presence of inclusive cues (e.g., institutional programs to support women in STEM), are likely to signal a sense of identity safety (Davies et al. 2005). The presence of cues may result in threat or safety depending on context, the intensity of the experience, and various individual difference variables (e.g., gender rejection sensitivity; London et al. 2012).

One potential threatening environmental cue is the historic and cultural representation of STEM as masculine fields (Eccles 2007; Hyde 2007). More specifically, scientists are typically depicted as male and as having masculine characteristics. This portrayal creates an impression that to be a woman scientist is "atypical" or that women are not equipped to be

scientists. Thus, women may feel as though they are ill-suited within their STEM discipline (Cheryan et al. 2005). Previous studies have manipulated the salience of male domination in STEM by providing overt statements of gender differences in test performance (specifically math; Spencer et al. 1999) and through statements made by sexist experimenters (Adams et al. 2006). Here, we focus mainly on potentially threatening or safe cues self-reported as present in individuals' immediate campus environment. These cues can include the number of women faculty and students in a department, witnessing discrimination or sexual harassment, and perceptions of university support for gender equity. Sensitivity to gender-based rejection may make interpretation of ambiguous situations as discriminatory more likely. Thus, we predict that women's gender rejection sensitivity will be negatively related to positive perceptions of campus climate (Hypothesis 2).

Individuals reporting greater gender stigma consciousness are more likely to interpret situations as discriminatory, so it is likely that women higher in gender rejection sensitivity will report more negative environmental cues in their STEM disciplines. Thus, gender rejection sensitivity may mediate the relation between gender stigma consciousness and actual reports of negative climate in STEM. We then expect that women's gender rejection sensitivity will mediate the relation between participants' gender stigma consciousness and perceptions of campus climate cues as positive or negative (Hypothesis 3).

Social Identity Threat

Perception of environmental cues is related to experiences of social identity threat and, more specifically, stereotype threat regarding gender and performance. Much of the research on social identity threat experienced by women in STEM has focused on stereotype threat, a specific type of social identity threat in which women worry their performance will be judged based on negative stereotypes of women (Steele and Aronson 1995). As a result, women in STEM may fear confirming these negative stereotypes through their behavior (e.g., test scores; performance) as true of them personally (Steele and Aronson 1995) or true of their social group (Shapiro and Neuberg 2007). Prior studies examining gender stereotype threat have done so by making gender particularly salient. For example, Spencer and colleagues (1999) notified female participants that a math test often showed gender differences. This resulted in significant decrements in performance on the test, whereas the effect was eliminated when participants were told the test did not show gender differences.

Stereotype threat can also be heightened by the presence of environmental cues related to discrimination (Murphy et al. 2007). These cues can signal that women are more likely to be targets of discrimination or that the environment is safe for

women (Davies et al. 2005). More specifically, we expect campus climate cues to be negatively related to stereotype threat, such that greater perceptions of positive campus climate are less likely to elicit stereotype threat. We therefore anticipate that women's perceptions of positive campus climate will be negatively related to self-reported experiences of stereotype threat (Hypothesis 4).

Whereas stereotype threat may impact any member of the stigmatized group within the stereotyped domain, those higher in gender rejection sensitivity are particularly vulnerable (London et al. 2012). Indeed, women higher in gender rejection sensitivity performed significantly worse on a subsequent math test than those lower in gender rejection sensitivity, particularly when the interviewer's attitude was ambiguous (Mendoza-Denton et al. 2009). Relatedly, in a longitudinal study of women students' attitudes, gender rejection sensitivity was positively related to fluctuations in perceived identity compatibility with STEM fields, as well as negatively related to performance (Ahlqvist et al. 2013). We expect similar relations here in that women's perceptions of campus climate will mediate the relation between gender rejection sensitivity and self-reported experiences of stereotype threat (Hypothesis 5).

Perceived Self-Control

One consequence of stereotype threat relevant to academic contexts is deficits in perceived control. Stressful life events can lead to decreases in self-control (Fabes and Eisenberg 1997). Situations where members of stigmatized groups experience stereotype threat may lead to constant monitoring of behavior, a form of self-control, to attempt to disconfirm stereotypes (Steele et al. 2002a, b). However, constant exertion of self-control (e.g., behavior monitoring) can impair subsequent self-control (Inzlicht et al. 2006). Experiences of stereotype threat lead to dysregulated physiological arousal (Ben-Zeev et al. 2005), decreased working memory (Schmader and Johns 2003), and deficits in intellectual performance (e.g., mathematics among women; Spencer et al. 1999). One underlying mechanism for these deficits is self-control, the ability to regulate one's thoughts and behaviors (Inzlicht et al. 2014). After stereotype threat, stigmatized individuals show decreased self-control (Inzlicht et al. 2006). Overall then, we expect that women's greater self-reported stereotype threat will predict lower perceived control (Hypothesis 6).

Based on prior research, stereotype threat is hypothesized to be a mechanism through which experiences with prejudice and discrimination via negative university campus climates negatively affects self-control (Inzlicht et al. 2006). We hypothesize then that stereotype threat will mediate the relation between perceptions of campus climate and perceived control (Hypothesis 7).

Academic Engagement and Persistence

Because research has documented the importance of perceived control in educational success (Murayama et al. 2013; Skinner et al. 1990), we examine how perceived control, and its depletion from stereotype threat, relates to academic engagement. Threatening experiences may result in a pattern of psychological disengagement or the psychological separation of the self from the threatening environment (e.g., math and/or science domains; Major and Schmader 1998). Decreased engagement occurs largely as a protective mechanism when in a stereotyped domain (Major and Schmader 1998). More specifically, women in STEM may psychologically disengage, or detach their sense of self-worth, from outcomes in STEM domains to protect their self-esteem. As conceptualized by Major and Schmader (1998) psychological disengagement includes three processes: disidentification from the domain, devaluing the domain, and discounting feedback in the domain.

There are multiple ways one may psychologically disengage. First, women may separate performance in the domain from their self-evaluations, referred to as disidentification (Major et al. 1998). More specifically, individuals experiencing chronic stereotype threat are less likely to see the stereotyped domain as an integral part of their identity (e.g., African Americans in science; Woodcock et al. 2012). Although protective in the short-term, chronically disidentifying from an academic domain is problematic and leads to leaving the domain (Woodcock et al. 2012). Second, women may devalue the domain or reduce the importance of achieving competency in the domain to their self-evaluations (Crocker and Major 1989). Devaluing an academic domain is problematic because students no longer care about their performance in the domain, which negatively impacts motivation (Inzlicht et al. 2009). Finally, women may discount feedback given in stereotyped domains, interpreting the feedback as biased rather than an accurate assessment of their skills and abilities (Loose et al. 2012). Again, this may serve a short-term ego-protective function, yet chronically discounting negative feedback is problematic because students miss out on the opportunity for academic development (Inzlicht et al. 2009).

We expect similar relations here, such that women reporting experiences of stereotype threat will be more likely to report disengagement (which includes disidentification, devaluing, and discounting) from STEM. Based on previous literature, we expect perceived control will mediate the relation between stereotype threat and disengagement. Specifically, we expect that women's perceived control will be negatively related to disengagement from STEM (Hypothesis 8) and that women's perceived control will mediate the relation between self-reported experiences of stereotype threat and disengagement from STEM (Hypothesis 9).

Effects on Self-Concept: Self-Esteem

As mentioned, disengagement from the threatening environment serves a protective function for one's self-esteem, a global evaluation of the self (Rosenberg 1979). High self-esteem has been linked to many positive outcomes including future success, job prestige, and income (Kammeyer-Mueller et al. 2008). Self-esteem is also related to higher levels of satisfaction and lower levels of burnout (Judge and Bono 2001). Experiences of social identity threat may be negatively related to self-esteem; therefore, it is expected that disengagement from these environments will be negatively related to self-esteem. The relation between disengagement and self-esteem could be positive or negative. Research suggests disengagement allows women to retain a positive self-image despite negative environmental cues in the stereotyped domain (Schmader et al. 2001). However, chronic exposure to social identity threat is likely to negatively impact self-esteem (Crocker and Major 1989; Schmitt et al. 2002). Given that women in STEM are likely chronically exposed to threat, we predict that women's disengagement from STEM will be negatively related to self-esteem (Hypothesis 10) and that women's disengagement from STEM will mediate the relation between perceived control and self-esteem (Hypothesis 11).

Representation: Gendered Contexts and Racial Minority Status

We discussed each component of the model of threatening academic environments including awareness of stigma and social identity threat theory, individual differences in vigilance and uncertainty; environmental cues that either confirm or disconfirm potential threat; research on social identity threat, self-control, academic engagement and persistence; and finally effects on self-esteem. Thus far we have made predictions for women in STEM as a whole. In the following, we describe our predictions for specific subgroups of women in STEM including women in male- and female-dominated STEM subfields (i.e., gendered context) and racial minority women in STEM.

Although women in STEM are largely underrepresented, there are some subfields in STEM that do not show gender disparities. For example, in the United States women make up 58% of students earning degrees in specialty areas of Biology whereas they are still largely underrepresented in majors such as mathematics, astronomy, Earth and atmospheric sciences, engineering, physics, and computer science (NSF 2015). These differences in STEM subfields likely create differences in experiences of threatening and safe environments among women (Casad et al. 2018, unpublished data). Women in female-dominated fields may not perceive their environments as threatening because they are not considered an

underrepresented population. Research indicates women undergraduates in pre-medical tracks exposed to successful women physicians have higher sense of belonging and interest in pursuing a medical-related career compared to those without exposure, indicating exposure to other successful women may be a protective factor for women in STEM (Rosenthal et al. 2013). In female-dominated STEM subfields, contact with female faculty and role models is more likely than in male-dominated STEM subfields (Casad et al. 2018, unpublished data).

However, despite the growing number of women students in some STEM fields such as biology and agricultural science, the number of women faculty in STEM remains much lower than the number of men (Nelson and Rogers 2003). Male-dominated STEM fields such as engineering, physics, and computer science may provide more threatening cues to women due to more prevalent masculine stereotypes regarding these fields (Cheryan et al. 2009). The overrepresentation of men in these majors may make threatening cues more salient compared to female-dominated majors where there is no such overrepresentation (Murphy et al. 2007). Because of these disparities between male- and female-dominated STEM subfields, we expect the proposed model will be different between these two groups. In sum, the model of threatening academic environments will be different for women in male- and female-dominated STEM subfields, such that relations between components will be stronger for women in male-dominated fields compared to female-dominated fields, indicating that women in male-dominated fields perceive their environments as more threatening compared to those in female-dominated fields (Hypothesis 12).

In our sample and analyses, majors were classified as female- or male-dominated based on enrollment statistics at the universities included in the sample (Casad et al. 2018, unpublished data). Majors that included 51% or more women were classified as female-dominated and majors that included 51% or more men were classified as male-dominated. The following majors are classified as female-dominated: biology, food science, animal science, and other majors (e.g., geology). The following majors are classified as male-dominated: engineering, kinesiology, math and statistics, computer science, biotechnology, chemistry, and physics (see online supplement Table 1s for enrollment data). The classifications based on enrollment statistics for our sample mirror the pattern of gender distribution for national baccalaureate graduation rates (NSF 2015). Enrollment statistics are higher than actual national graduate rates within these disciplines. Because we are interested in the role of social climate, we focused on enrollment for gender representation because this represents the gender distribution in classrooms, rather than graduation rates, which are calculated after the student leaves the university environment.

Other data (Casad et al. 2018, unpublished data). Indicate that women in male-dominated STEM fields are more likely

to leave STEM or switch to a female-dominated STEM major than women in female-dominated STEM majors are. In the present sample, all but four participants graduated in their declared major. For our sample, enrollment rates and graduation rates were highly similar. Psychology majors, which include 75% women, were excluded because at the Western university psychology is treated as a social science rather than as a natural science and 90% or more of the undergraduate majors have an interest in pursuing non-research careers in psychology practice. There is no research-based graduate program in the department. For these reasons, the climate in the department is likely not similar enough to STEM departments and being conservative, we chose to exclude Psychology majors. In contrast, Psychology at the Midwestern university is treated as a natural science and has research-based doctoral programs. However, we chose to use the same sampling approach and excluded Psychology majors.

In addition to women being underrepresented as women, racial minorities are also largely underrepresented in STEM fields (Chen and Soldner 2014). In the United States, underrepresented racial minorities in STEM include African Americans, Latino/as, and Native Americans. Although the participation of racial minorities in STEM is increasing (17% in 2000 to 20% in 2011; National Science Board 2014), they are still underrepresented compared to their representation in the general population aged 25–29 at 36% in 2011 (U.S. Census Bureau 2014). Compared to White students, African Americans, Latino/as, Native Americans and other underrepresented minorities are more likely to leave STEM fields early in their undergraduate careers (Hurtado et al. 2010).

Research has shown that identifying with two stigmatized groups may lead to greater disengagement when experiencing social identity threat compared to identifying with only one stigmatized identity (Baysu et al. 2011). The intersections of multiple sources of stigma (both gender-based and race-based) may create more threatening environments for women who are also racial minorities in STEM (Cole 2009). Thus, we hypothesize that the model of threatening academic environments will be different for White women compared to racial minority women, such that relations between all components will be stronger for racial minorities compared to Whites, indicating racial minorities perceive their environments as more threatening and have more negative outcomes compared to racial majority members (Hypothesis 13).

Method

Participants

Participants were 579 U.S. undergraduate women students majoring in a STEM discipline recruited from a Western and a Midwestern public university who were offered extra course credit or $10 in exchange for participation. Participants from the Western university were 114 (28.6%) Asian Americans, 100 (25.1%) Latinas, 100 (25.1%) Whites, 44 (11.1%) Multiracial individuals, 14 (3.5%) African Americans, and 26 (6.6%) who reported they were Middle Eastern, Native American, Pacific Islander, or another racial/ethnic group. Participants from the Midwestern university were of 121 (66.9%) Whites, 51 (28.2%) African Americans, and 9 (4.9%) who reported they were Multiracial, Asian American, or another racial/ethnic group. Participants in female-dominated majors included biology (263, 45.4%), animal science (37, 6.4%), food science (39, 6.7%), and other fields (3, e.g., .5% geology). Participants in male-dominated majors included engineering (81, 14%), kinesiology (57, 9.8%), mathematics (30, 5.2%), chemistry (23, 4%), computer science (32, 5.5%), and other fields (14, e.g., 2.2% physics, .2% plant science).

Procedure and Measures

Participants signed up to complete the study on Sona Systems (Bethesda, MD), a human participant pool management system. Prior to starting the online questionnaire, participants were required to complete a series of prescreen measures to determine eligibility for the study including having a heart murmur, pacemaker, high blood pressure, clinical anxiety, clinical depression, cardiovascular medication regimen, pregnancy or lactation (all exclusionary criteria), and major. If they were eligible, participants could complete the questionnaire, which took approximately 45 min to complete. The questionnaire was described as assessing students' experiences in their math and science degree programs including attitudes, classroom experiences, and university curriculum.

Gender Stigma Consciousness

Chronic awareness of stigmatized status among women was assessed using 10 items ($\alpha = .82$) developed by Pinel (1999). All items were rated on a 6-point scale from 1 (*Very strongly disagree*) to 6 (*Very strongly agree*). Example items included "Stereotypes about women have not affected me personally" (reverse coded) and "Most men have a problem viewing women as equals." Higher averaged scores indicate greater gender stigma consciousness.

Gender Rejection Sensitivity

Sensitivity to rejection based on gender was assessed using a modified version of the gender rejection sensitivity scale developed by London et al. (2012). Five of the original 11 scenarios (scenarios 4, 5, 7, 8, 10) were used to shorten the overall questionnaire. The five scenarios included all scenarios about

science and math classrooms but the term "STEM" was substituted for "science" so the measure would apply to engineering and mathematics majors. A sample scenario is: "Imagine that it is the first day of school and in your STEM class all the students have to create teams to work on assignments during the semester. Most of the groups are already full except for a few groups of all men." Each scenario was followed by two Likert-type scales assessing worry and likelihood: "How worried would you be that you would not be picked to join one of the all-male groups because you are a woman?" was rated on a 6-point scale from 1 (*Not at all worried*) to 6 (*Very worried*); "How likely is it that the professor would not choose you?" was rated on a 6-point scale from 1 (*Not at all likely*) to 6 (*Very likely*).

To compute sensitivity scores, the score of expected worry was multiplied by the expected likelihood of rejection for each situation. One scenario included an additional reverse-coded item assessing worry: "How worried would you be that you would be picked to join one of the all-male groups because you are a woman?" An additional sensitivity item was computed by multiplying the reverse-coded worry by the expected likelihood of rejection, creating a total of six sensitivity items. An average of these six indices was used as a measure of rejection sensitivity such that higher scores indicate greater gender rejection sensitivity ($\alpha = .77$), following procedures outlined in London et al. (2012).

Campus Climate Cues

Environmental cues relevant to discrimination were assessed using the climate scale developed by Schultz (2012). This scale consists of seven items ($\alpha = .85$) and concerns the degree to which participants agree that the university, department, and faculty are supportive of female students. All items were rated on a 6-point scale from 1 (*Very strongly disagree*) to 6 (*Very strongly agree*), where agreement indicated less presence of discrimination or more supportive environments. Example items include: "My department is supportive of female students" and "There are effective female role models in my department." Higher averaged scores indicate more positive campus climate.

Stereotype Threat

A commonly used self-report measure of stereotype threat is the Stereotype Vulnerability Scale developed by Spencer (1993). This measure assesses feelings of threat based on negative stereotypes about intellectual inferiority in one's academic domain (Steele et al. 2002a). The measure consists of eight items ($\alpha = .87$) designed to assess the frequency with which women experience threat in academia, with the lead-in statement "How often do you feel that because of your gender…" and items such as "…Professors expect you to do poorly" and "…Some people believe that you have less

ability." All items were rated on a 5-point scale from 1 (*Never*) to 5 (*Almost always*). Higher averaged scores indicate greater experiences of stereotype threat.

Perceived Control

General perceived control was assessed using seven items ($\alpha = .82$) adapted from Sparks et al. (1997). Items were rated on a 6-point scale from 1 (*Very strongly disagree*) to 6 (*Very strongly agree*). Example items included: "I often feel helpless in dealing with the problems of life" and "I have little control over the things that happen to me" (reverse coded). Higher averaged scores indicate greater perceived control.

Psychological Disengagement

Psychological disengagement from math and science was assessed using three subscales developed by Major and Schmader (1998) worded to create measures for math and science. These subscales concerned the degree to which participants disidentified from math (3 items, $\alpha = .65$) and science (3 items, $\alpha = .62$; e.g., "I really don't care what tests say about my math/science abilities"), discounted math (4 items, $\alpha = .76$) and science (4 items, $\alpha = .77$; e.g., "I feel that math/science tests are biased against me"), as well as devalued math (5 items, $\alpha = .78$) and science (5 items, $\alpha = .87$; e.g., "It usually doesn't matter to me one way or the other how I do on math/science tests"). Consistent with previous research, the subscales of psychological disengagement often have lower reliability (Major et al. 1998), which is the case for math and science disidentification. All items were rated on a 6-point scale from 1 (*Very strongly disagree*) to 6 (*Very strongly agree*). The average of each subscale was used as an item-level indicator in the model to reduce model complexity. Higher averaged values indicate higher disengagement.

Self-Esteem

Self-esteem was assessed using a measure developed by Rosenberg (1979). This scale consists of 10 items ($\alpha = .91$) rated on a 6-point scale from 1 (*Very strongly disagree*) to 6 (*Very strongly agree*). Participants rated the degree to which they generally feel positively about themselves (e.g., "I feel that I am a person of worth, at least on equal basis with others"). Higher averaged values indicate greater self-esteem.

Analytical Approach

Confirmatory factor analysis (CFA) and structural equation modeling (SEM) through Analysis of Moment Structures (AMOS) Version 23.0 (Arbuckle 2014) were used to test the hypothesized model. Fit was examined using three indices including the Chi-square test statistic, Steiger's (1990) root

mean square error of approximation (RMSEA), and the comparative fit index (CFI; Bentler 1990). Whereas Chi-square values are likely to be statistically significant for models due to sample size and violation of assumptions of normality (Byrne 2013), this test allows for a comparative test of models where a significant difference indicates a superior fit than the preceding model. RMSEA makes an adjustment for model complexity (e.g., multiple paths and predictors), whereas CFI is negatively affected by greater numbers of parameters in the model. Criteria for assessing model fit have ranged from less conservative, with RMSEA ≤ .08 and CFI ≥ .80 (Andreu et al. 2006; Kenny 2015; Satorra and Bentler 1994), to more conservative, with RMSEA ≤ .06 and CFI ≥ .95 (Hu and Bentler 1999). However, scholars have cautioned that using more stringent criteria when models are complex and sample sizes are below 500 may result in incorrectly rejecting models (Weston and Gore 2006). In the present study, the model is complex (including four mediation models and testing competing models) and sample sizes range from 464 to 579 for total sample and subgroup comparisons, therefore a more liberal RMSEA criterion is most appropriate to adjust for model complexity; however, CFI is reported for descriptive purposes and interpreted with caution.

A CFA was first specified to establish measurement quality among study variables. Then, a model specifying the fully-mediated model was tested using SEM. To test for differences between groups, a baseline model based on the hypothesized model was first specified allowing all parameters to be freely estimated across groups. To test for invariance of factor loadings and regression weights, subsequent models were specified constraining factor loadings and regression weights, respectively, between groups. To assess significant differences between groups, a Chi-square difference test was conducted by subtracting the Chi-square value from constrained models from the baseline model (Byrne 2013). To test the mediation hypotheses, the bootstrapping feature within AMOS was used, which provides confidence intervals around the path estimates derived from SEM as well as all indirect effects. Alternative competing models were then tested against the proposed model. Lastly, differences between male- and female-dominated STEM majors and racial groups were assessed. Prior to analyses, a series of independent sample t-tests were computed for the Western and Midwestern samples to compare each sample on the variables included in the model. Results indicated the means of the samples did not differ by institution, all $ps > .05$; therefore, the two samples were combined for analyses.

Results

Table 1 includes means, standard deviations, correlations between variables, and scale reliabilities for variables in the model, demonstrating null-to-moderate relations between all study variables across the sample. Expected correlations emerged among similar variables such as the three measures of disengagement (discounting, devaluing, and disidentification). Gender (stigma consciousness and rejection sensitivity) and threat-related variables (stereotype threat, campus climate) also are correlated. Interestingly, all variables except science disidentification are correlated with self-esteem.

A CFA was conducted among all study variables which provided adequate fit to the data, $\chi^2(1243) = 3346.47, p < .001$; RMSEA = .054; CFI = .86, suggesting items loaded onto latent constructs (see online supplement Table 2s for factor loadings). Two items, math ($\beta = .24$) and science ($\beta = .28$) disidentification, part of the disengagement construct, had particularly low factor loadings and were removed from analyses. Including these subscales indicated poorer fit for the fully mediated model, $\chi^2(1361) = 4489.27, p < .001$; RMSEA = .06; CFI = .80. Excluding these subscales also significantly reduced the χ^2 value of overall model fit, $\chi^2(103) = 673.18, p < .001$. The final CFA with the two items removed showed similar model fit, $\chi^2(1346) = 3976.65, p < .001$; RMSEA = .058; CFI = .83.

Tests of Direct Effects

A model specifying fully-mediated effects provided adequate fit to the data after examining all fit indices, $\chi^2(1258) = 3816.09, p < .001$; RMSEA = .059; CFI = .83 (see Fig. 2). We first discuss hypotheses proposing direct effects using parameter estimates in the hypothesized model. Gender stigma consciousness was positively related to gender rejection sensitivity ($\beta = .38, p < .001$), supporting Hypothesis 1. Greater gender rejection sensitivity predicted less positive perceptions of climate ($\beta = -.37, p < .001$), supporting Hypothesis 2. Perceptions of positive campus climate were negatively related to stereotype threat ($\beta = -.29, p < .001$), supporting Hypothesis 4. Stereotype threat was negatively related to perceived control ($\beta = -.21, p < .001$), supporting Hypothesis 6. Perceived control was negatively related to disengagement from the domain ($\beta = -.61 \ p < .001$), supporting Hypothesis 8. Finally, disengagement from the domain was negatively related to self-esteem ($\beta = -.73, p < .001$), supporting Hypothesis 10. Participants who disengaged from the domain had lower self-esteem, indicating disengagement did not serve an ego-protective function, likely due to chronic experiences with threat. In sum, all hypotheses of the direct effects were supported in the theoretical and empirical model.

Tests of Mediated Effects

Gender rejection sensitivity significantly mediated the relation between gender stigma consciousness and perceptions of

Table 1 Descriptive statistics, alphas, correlations between study variables, and hypotheses

		Correlations											
Variables	M (SD)	1	2	3	4	5	6	7	8	9	10	11	12
1. Gender stigma consciousness	3.49 (.59)	(.82)											
H1: Gender stigma consciousness will be positively related to gender rejection sensitivity.													
2. Gender rejection sensitivity	7.59 (3.41)	.39**	(.77)										
H2: Gender rejection sensitivity will be negatively related to positive perceptions of campus climate.													
H3: Gender rejection sensitivity will mediate the relation between gender stigma consciousness and perceptions of campus climate cues.													
3. Perception of campus climate	4.37 (.73)	−.20**	−.27**	(.85)									
H4: Perceptions of campus climate will be negatively related to stereotype threat.													
H5: Perceptions of campus climate will mediate the relation between gender rejection sensitivity and stereotype threat.													
4. Identity threat	2.17 (.79)	.46**	.48**	−.22**	(.88)								
H6: Stereotype threat will be negatively related to perceived control.													
H7: Stereotype threat will mediate the relation between campus climate and perceived control.													
5. Perceived control	4.34 (.72)	−.05	−.22**	.37**	−.20*	(.82)							
H8: Perceived control will be negatively related to disengagement from STEM (discounting, devaluating, disidentification).													
H9: Perceived control will mediate the relation between stereotype threat and disengagement.													
6. Math discounting	2.95 (.67)	.15**	.25**	−.31**	.19**	−.31**	(.76)						
7. Math devaluing	2.57 (.71)	−.01	.06	−.25**	.04	−.28**	.47**	(.78)					
8. Math disidentification	3.35 (.80)	−.04	−.06	−.01	−.07	−.01	.17**	.38**	(.65)				
9. Science discounting	2.89 (.71)	.20**	.26**	−.40**	.25**	−.31**	.63**	.41**	.12**	(.77)			
10. Science devaluing	2.32 (.77)	−.02	.09*	−.35**	.07	−.26**	.28**	.69**	.25**	.46**	(.87)		
11. Science disidentification	3.20 (.88)	−.08	.01	−.13**	−.04	−.10*	.15**	.30**	.67**	.23**	.44**	(.62)	
12. Self-esteem	4.48 (.80)	−.10*	−.29**	.47**	−.20**	.53**	−.37**	−.30**	.10*	−.38**	−.27**	.02	(.91)
H10: Disengagement will be negatively related to self-esteem													
H11: Disengagement will mediate the relation between perceived control and self-esteem													

Reliability (Cronbach's alpha) indices are reported in parentheses on the diagonal of the correlation matrix. H = Hypothesis

*p < .05. **p < .01

campus climate (β = −.12, p = .002, 95% CI [−.18, −.07]), supporting Hypothesis 3. Specifically, higher stigma consciousness predicted perceptions of more negative campus climate; however, the relation was explained by higher gender rejection sensitivity. Perception of campus climate significantly mediated the relation between gender rejection sensitivity and stereotype threat (β = .60, p = .013, 95% CI [.48, .68]), supporting Hypothesis 5. Specifically, greater gender rejection sensitivity predicted greater experiences of stereotype threat; however, the relation was explained by more negative perceptions of campus climate. Stereotype threat significantly mediated the relation between perceptions of campus climate and perceived control (β = .40, p = .016, 95% CI [.25, .51]), supporting Hypothesis 7. These results suggest the perception of positive campus climate predicted greater perceived control; however, this relation was explained by lower levels of stereotype threat.

Perceived control significantly mediated the relation between stereotype threat and disengagement (β = .24, p = .007, 95% CI [.14, .34]), supporting hypothesis 9. Specifically, greater stereotype threat predicted greater disengagement; however, the relation was explained by

lower perceived control. Finally, there was a significant indirect effect of perceived control predicting self-esteem through disengagement (β = .41, p = .018, 95% CI [−.31, .51]), supporting Hypothesis 11. Greater perceived control predicted higher self-esteem; however, the relation was explained by disengagement from math and science, such that lower perceived control leads to higher disengagement, which predicts lower self-esteem. All hypothesized mediations remained significant after controlling for direct effects of all other variables in the model (all ps < .027).

Alternative Models

The individual difference variable (i.e., gender stigma consciousness) and vigilance (i.e., gender rejection sensitively) were highly related constructs, r(577) = .39, p < .001. To assess whether these constructs were redundant in the model, we tested an alternative model excluding each of these variables separately to examine whether these constructs contributed to the overall fit of the model or if they could be excluded from the model for parsimony. Although the alternative model had

Fig. 2 Empirical test of the model of threatening academic environments. Each oval represents a construct from Inzlicht et al.'s (2009) model followed by the variable from the present study that operationally defines that construct (i.e., construct: Definition). H = hypothesis. Hypotheses 3, 5, 7, 9, and 11 reflect the mediational models
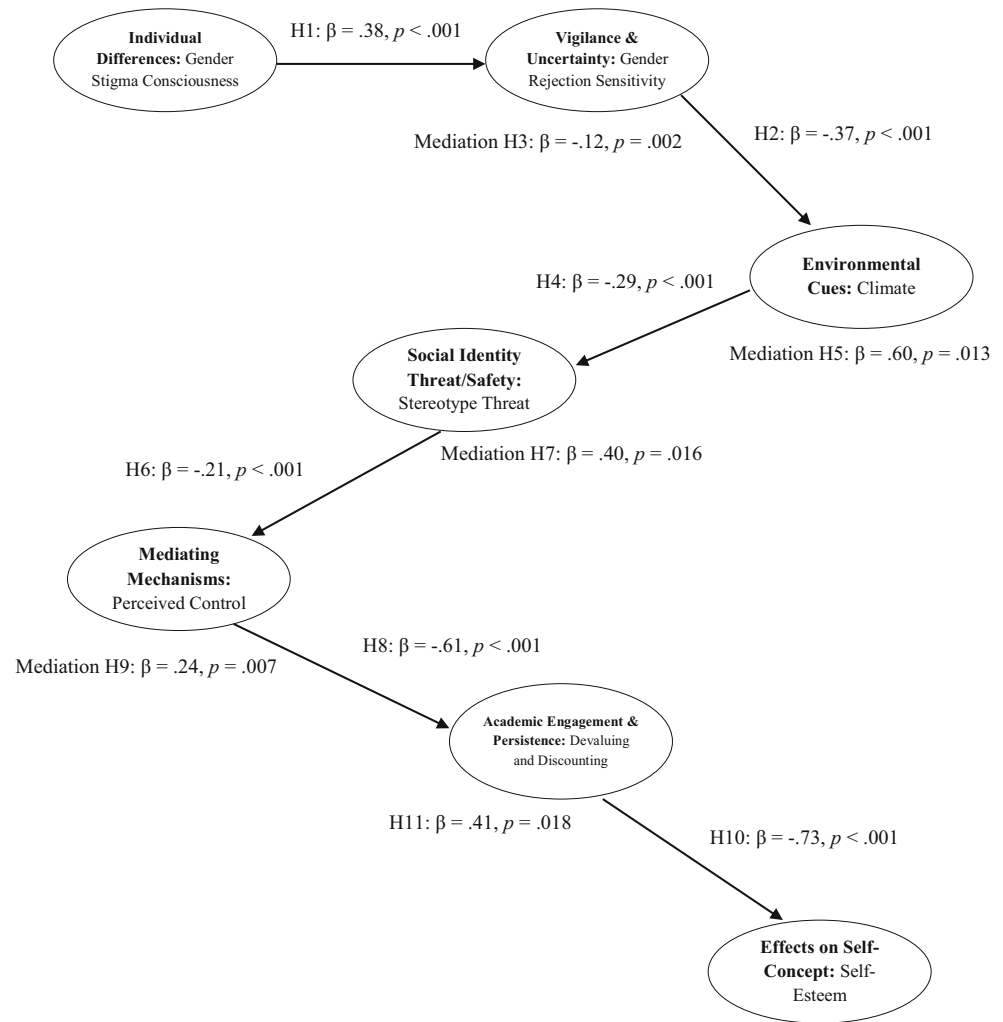
a significantly lower Chi-square value as indicated by the Chi-square difference test, $\chi^2(675) = 1573.93$, $p < .001$, RMSEA indicated poorer fit to the data, $\chi^2(583) = 2242.16$, $p < .001$; RMSEA = .07; CFI = .86. These results suggest that although this alternative model had a significantly lower Chi-square value, the ratio between estimated parameters, sample moments, and the observed Chi-square statistic were indicative of poorer model fit compared to the original hypothesized model.

In addition, we sought to examine whether the order of these constructs affected model fit. Results indicated switching the order of gender stigma consciousness and gender rejection sensitivity had similar model fit, $\chi^2(1258) = 3853.42$, $p < .001$; RMSEA = .06; CFI = .83. However, the indirect effect of gender stigma consciousness on the relation between gender rejection sensitivity and campus climate cues was not significant ($\beta = -.02$, $p = .47$, 95% CI [−.07, .03]). This indicates that the original hypothesized path of gender stigma consciousness as an individual difference variable and gender rejection sensitivity as the vigilance variable should be kept.

Male-Dominated Versus Female-Dominated STEM Subfields

The fit of the theoretical model was tested between male- and female-dominated STEM majors because research suggests that women in male-dominated domains may perceive their educational environments as more threatening compared to those in female-dominated domains where women are better represented in STEM (Casad et al. 2018, unpublished data). Majors were dummy coded into either male- (e.g., engineering, mathematics, etc.; $n = 237$) or female-dominated majors (e.g., biology, geology, etc.; $n = 342$) based on the enrollment statistics at the universities. Majors were considered female-dominated if the enrollment consisted of at least 51% women, and male-dominated if enrollment reflect at least 51% men.

Results indicated this model provided adequate fit of the baseline model between subfields, $\chi^2(2516) = 5493.49$, $p < .001$; RMSEA = .05; CFI = .81. The model assessing invariance of factor loadings between subfields indicated no significant difference between the baseline model, $\Delta\chi^2(45) = 33.80$, $p = .889$, suggesting there were similar factor loadings onto all

latent variables between male- and female-dominated majors. The model assessing invariance of the regression estimates indicated a significant difference between the baseline model, $\Delta\chi^2(103) = 189.83$, $p < .001$, demonstrating that estimated regression weights differed between male- and female-dominated fields.

Because the invariance regression weight model was significantly different from the baseline model, each path of the model was tested for differences of regression weight estimates (see Table 2). Descriptive statistics and mean comparisons are provided for additional information (see Table 3). Results show there was a significant difference of the path between gender stigma consciousness and gender rejection sensitivity between male- ($\beta = .47$) and female- ($\beta = .31$) dominated majors, $\Delta\chi^2(31) = 64.10$, $p < .001$, such that women in male-dominated STEM majors had a stronger relation between these variables compared to those in female-dominated STEM majors. However, there were no significant differences in ratings of gender stigma consciousness or rejection sensitivity between major subtypes. Similarly, there was a significant difference between groups for the path between perceived campus climate and experiences of stereotype threat between male- ($\beta = -.31$) and female- ($\beta = -.22$) dominated majors, $\Delta\chi^2(29) = 52.55$, $p = .004$, such that those in male-dominated STEM majors had a stronger relation between these variables compared to women in female-dominated STEM majors.

Furthermore, women in male-dominated majors report experiencing more negative campus climate ($M = 4.29$, $SD = .73$) than did women in female-dominated majors ($M = 4.43$, $SD = .72$), $t(577) = 2.33$, $p = .02$, $d = .19$, but there were no group differences in experiences of stereotype threat. Results indicate there was a significant difference of the path from perceived control to disengagement between male- ($\beta = -.54$) and female- ($\beta = -.27$) dominated majors, $\Delta\chi^2(21) = 80.63$, $p < .001$, such that women in male-dominated STEM majors had a stronger relation between these variables compared to those in female-dominated STEM majors. There were no group differences in perceived control, but women in female-dominated majors reported more math devaluing ($M = 2.66$, $SD = .66$) and math discounting ($M = 3.44$, $SD = .78$) than did women in male-dominated majors—devaluing: ($M = 2.44$, $SD = .76$), $t(577) = 3.718$, $p = .001$, $d = .31$; discounting: ($M = 3.23$, $SD = .81$), $t(577) = 3.18$, $p = .002$, $d = .26$.

There was also a significant difference of the path from disengagement to self-esteem between male- ($\beta = -.51$) and female- ($\beta = -.41$) dominated majors, $\Delta\chi^2(27) = 67.92$, $p < .001$, demonstrating this relation was stronger in male-dominated fields compared to those in female-dominated fields. There were no group differences in self-esteem. All other paths of the model were not significantly different between groups (all $ps > .05$). These results indicate some support for Hypothesis 12 that the model would be stronger for women in male- versus female-dominated STEM majors (see Table 2 for regression weights and Table 3 for means).

Comparison between Racial Groups

The fit of the hypothesized model was tested between White women and racial minority women because research suggests having a intersecting minority statuses may lead to greater stigma and stereotype threat and, subsequently, negative outcomes. Self-reported racial identity was dummy coded into majority (i.e., White, Asian American; $n = 336$) or minority (e.g., Black, Latina, Multiracial; $n = 243$) racial groups. Because Asian Americans have a moderately high social status in the U.S. (O'Brien and Major 2005), are overrepresented in STEM fields compared to population statistics (NSF 2015), and report greater intentions to pursue STEM-related careers compared to all other racial groups (NSF 2015), all participants identifying as Asian American were removed from analyses ($n = 115$). Including Asian Americans in the racial majority group indicated poorer fit indices, $\chi^2(2516) = 5722.10$, $p < .001$; RMSEA = .06; CFI = .76. Similarly, including Asian Americans in the racial minority group also indicated poorer model fit, $\chi^2(2516) = 5862.19$, $p < .001$; RMSEA = .06; CFI = .70. Further, whereas stereotypes concerning racial minorities relevant to STEM are generally negative (e.g., lack of intelligence), STEM-relevant stereotypes concerning Asian Americans are positive (e.g., above average intelligence; Son and Shelton 2011).

Like the model fit between male- and female-dominated groups, the baseline model estimated between racial groups indicated adequate fit, $\chi^2(2516) = 5082.43$, $p < .001$; RMSEA = .05; CFI = .80. The model assessing the invariance of factor loadings showed no significant difference between groups, $\Delta\chi^2(45) = 19.82$, $p = .999$, indicating there were no differences in factor loadings between White and racial minority women. However, the model assessing invariance of regression weights was significantly different from the baseline model, indicating differences between structural weights for White compared to racial minority women, $\Delta\chi^2(103) = 250.03$, $p < .001$ (see Table 2). Descriptive statistics and mean comparisons are provided for additional information (see Table 3).

Gender stigma consciousness predicted higher rejection sensitivity for racial minorities ($\beta = .55$) compared to Whites ($\beta = .24$), $\Delta\chi^2(31) = 96.29$, $p < .001$. There were no group differences in gender stigma consciousness, but racial minority women reported higher gender rejection sensitivity ($M = 8.03$, $SD = 3.72$) than did White women ($M = 7.05$, $SD = 3.06$), $t(462) = 3.08$, $p = .002$, $d = .29$. Perceived control predicted significantly higher disengagement for racial minorities ($\beta = -.83$) compared to Whites ($\beta = -.51$), $\Delta\chi^2(18) = 28.98$, $p < .001$. There were no group differences in perceived control, but racial minority women reported more math and science disengagement than did White women. Racial minority

Table 2 Estimated standardized regression weights for structural paths between groups

Path	Whole model	Male-dominated	Female-dominated	Whites	Racial minorities
Gender stigma consciousness to rejection sensitivity	.376	.468	.306	.244	.544
Rejection sensitivity to campus climate	−.365	−.322	−.297	−.369	−.420
Campus climate to stereotype threat	−.285	−.306	−.220	−.309	−.369
Stereotype threat to perceived control	−.212	−.174	−.158	−.279	−.310
Perceived control to disengagement	−.605	−.540	−.272	−.511	−.834
Disengagement to self-esteem	−.732	−.506	−.413	−.638	−.662

women had higher math ($M = 3.46$, $SD = .81$) and science ($M = 3.35$, $SD = .87$) discounting compared to White women's math ($M = 3.31$, $SD = .81$) $t(462) = 1.97$, $p = .049$, $d = .19$, and science ($M = 3.12$, $SD = .93$), $t(462) = 2.788$, $p = .006$, $d = .25$, discounting. There were group differences in math and science disidentification, but because the variables were removed from the model, they are not discussed. All other paths of the model were not significantly different between groups (all p-s > .05). Thus, Hypothesis 13 that racial minority women would have an overall stronger model than White women's received some support (see Table 2 for regression weights and Table 3 for means).

Discussion

Overall, our results suggest adequate fit of the data to the hypothesized model. Ours is the first known study to test the theoretical model in its entirety, testing direct and meditational paths with vulnerable populations who may perceive their educational environments as threatening (e.g., women pursuing degrees in male-dominated domains; racial minority women in STEM). Supporting Inzlicht and colleagues' (2009) model of threatening academic environments, women in STEM experience negative campus climate and social identity threat that predict their academic engagement and self-esteem. Greater gender stigma consciousness predicts greater gender rejection sensitivity, which in turn predicts more negative perceptions of campus climate. Negative perceptions of campus climate predict greater experiences of stereotype threat, which predict lower perceived control. Lower perceived control predicts greater academic disengagement, which in turn predicts lower self-esteem. The four mediational models were also supported. As hypothesized, the model was stronger for women in STEM who are particularly vulnerable to stigma and negative outcomes including women in male-dominated STEM subfields and racial minority women.

Analyses between male- and female-dominated fields provided some support for our hypothesis that women in male-

Table 3 Means of latent factors between groups

Scale	Whole model	Male-dominated	Female-dominated	Whites	Racial minorities
Gender stigma consciousness (1–6)	3.49	3.47	3.51	3.48	3.53
Gender rejection sensitivity (1–36)	7.59	7.82	7.44	7.05**	8.03**
Climate cues (1–6)	4.37	4.29*	4.43*	4.40	4.48
Stereotype threat (1–6)	2.17	2.17	2.17	2.16	2.26
Perceived control (1–6)	4.34	4.31	4.36	4.39	4.38
Disengagement (1–6)					
Math disidentification	2.95	2.89	2.98	2.76***	3.07***
Math devaluing	2.57	2.44***	2.66***	2.51	2.59
Math discounting	3.35	3.23**	3.44**	3.31*	3.46*
Science disidentification	2.90	2.90	2.89	2.70***	2.99***
Science devaluing	2.33	2.39	2.28	2.24	2.34
Science discounting	3.23	3.31	3.18	3.12**	3.35**
Self-esteem (1–6)	4.48	4.46	4.50	4.59	4.57

Significant mean differences between groups, male-dominated compared to female-dominated majors, and Whites compared to racial minorities, are marked

*$p < .05$. **$p < .01$. ***$p < .001$

dominated STEM fields exhibit stronger relationships between experiencing threat and negative outcomes than do women in female-dominated fields. Paths that were significantly stronger in the predicted direction among women in male-dominated fields include gender stigma consciousness→gender rejection sensitivity, perceived campus climate→stereotype threat, perceived control→disengagement, and disengagement→self-esteem. Comparison of group means indicated women in male-dominated fields reported more negative campus climate, but women in female-dominated majors reported greater math disengagement. It is not surprising that women in female-dominated STEM subfields report more negative perceptions of math because these fields are less math-intensive than male-dominated STEM subfields like physics, engineering, and computer science (University data 2009).

Our results from the between-groups analysis for majority and minority racial groups provided partial support for our hypothesis that because racial minority women in STEM have intersecting disadvantaged statuses, they may demonstrate stronger relationships between experiencing threat and negative outcomes than White women do. Paths that significantly differed in strength included gender stigma consciousness→rejection sensitivity and perceived control→disengagement. Comparison of group means indicated racial minority women reported greater gender stigma consciousness, as well as more math and science disengagement, than White women did. These results indicate racial minority women in STEM may be more susceptible to experiencing their educational environments as threatening compared to racial majority women.

This disparity between Whites and racial minorities may be explained by the experiences of intersecting disadvantaged statuses (gender and racial identity) which has been shown to lead to greater disengagement under threat (Baysu et al. 2011). Research has indicated that single identity minorities (e.g., those who identify with only one stigmatized group) or women with well-integrated identities (e.g., women who blend their gender and science identity) do not show high disengagement under threat compared to those with intersecting disadvantaged statuses (Baysu et al. 2011). However, we did not measure participants' intersecting identities or identity compatibility in our model (see Ahlqvist et al. 2013 and Rosenthal et al. 2013). Further, our measures of vigilance, climate, and stereotype threat focused on sexism. Racial minority women also experience racism, which is not accounted for in our model, thus the extent of perceived threat and negative academic and psychological outcomes may be underestimated.

Research suggests experiences among individuals with intersecting disadvantaged statuses are not homogeneous (Purdie-Vaughns and Eibach 2008). For example, Asian American women are better represented in STEM than are Black and Latina women (NSF 2015). Research suggests

Black women may have different responses to stigma in STEM depending on their academic context and racial identity (O'Brien et al. 2015). For example, Black women at Historically Black Colleges and Universities (HBCUs) have higher graduation rates in STEM than do Black women at predominately White universities (National Science Board 2014), likely due in part to more supportive campus environments at HBCUs (Hurtado 1992).

Limitations

Despite the contributions of testing the theoretical model with multiple groups, our study is not without limitations. First, the data are cross-sectional and correlational, which limits causal claims. The data are also self-report and were collected online. There are some measurement limitations, with some latent factors showing lower factor loadings (e.g., gender stigma conscious, math/science disidentification, and science devaluing). Finally, although RMSEA values were below .06, indicating good model fit (Hu and Bentler 1999), CFI values were between .80 to .86 indicating fair model fit according to less conservative criteria (Kenny 2015). However, given our model's complexity, including four mediational models and several paths, as well as our moderate sample sizes, lower CFI values are expected (Weston and Gore 2006).

Another limitation is the exclusion of Asian American women from analyses and the inability to model their data separately due to a small sample size ($n = 115$). As previously discussed, Asian American women in STEM are a unique case in which they belong to a stigmatized group (i.e., women), but also a positively stereotyped group (i.e., Asians). Of course, the model minority stereotype and positive stereotypes can be problematic (Cheng et al. 2017), but research shows that Asian American women's experience in math differs by identity salience and that positive stereotypes can create "stereotype boost" (Shih et al. 2012). Shih et al. (1999) showed that when Asian American women's racial identity is salient, they perform better on a math test, reflecting a boost in performance due the positive stereotype of Asian's superiority in math (or "stereotype boost"). However, when Asian American women are primed to make their gender identity salient, the typical drop in math performance due to stereotype threat is produced. This finding provides further support for the complexities of intersectionality that the data in the present study cannot address (Shih and Sanchez 2009).

Future Research Directions

Our results are encouraging and lend support to the model proposed by Inzlicht and colleagues (2009); however, the presence of adequate fit does not rule out superior-fitting models for our data. The alternative models presented in the current study provide support for individual difference

variables and the order in which they should occur in the model. However, future research, particularly longitudinal studies, should replicate our model with more alternative model comparisons, mainly looking at model fit regarding the importance of individual difference variables. Although we have shown support for the order in which these individual differences should be modeled, future research should further establish the efficacy of these variables as they unfold over time. Longitudinal tests of the model would more accurately capture the "chain of psychological events" that unfold over time for stigmatized groups in threatening academic environments, reflecting Inzlicht and colleagues' (2009, p. 20) original intent for the model.

Although our hypothesis indicating academic disengagement is negatively related to self-esteem was supported in the current study and consistent with prior research (e.g., Schmitt et al. 2002), there are concerns with measuring disengagement as an overarching construct, combining all subscales, rather than using each subscale as a distinct construct. More specifically, Loose and colleagues (2012) proposed and tested the hypothesis that discounting and devaluing are separate strategies with divergent impact on self-esteem. Discounting is more temporary and allows maintenance of identification with the domain and a temporary detachment of the self from negative feedback to occur simultaneously (Lesko and Corpus 2006; Major and Schmader 1998). Devaluing, alternatively, suggests complete withdrawal from the domain of interest, which may be more threatening than protective to one's identity and self-esteem (Loose et al. 2012). Our data indicate discounting and devaluating are negatively related to self-esteem, but math disidentification is positively related to self-esteem. Future research should attempt to determine the relative impact of each subtype of disengagement on self-esteem rather than studying them as a unitary construct (Major et al. 1998). It is important to determine the impact of disengagement on additional outcomes as well. Despite the ability of decreased engagement to be protective of one's self-concept, it may negatively impact task performance and persistence (Crocker and Major 1989; Schmader et al. 2001). Thus, it is probable that women experiencing negative environments within STEM are less likely to persist in these fields. Future research should test the model for longitudinal impact on GPA and persistence in the major as mediated by disengagement.

Future research should more closely examine issues of identity and intersectionality to better understand the experiences of racial minority women in STEM, including Asian American women (Cole 2009; Purdie-Vaughns and Eibach 2008). To adequately capture experiences with multiple stigmas, researchers need to measure variables assessing gender-related threats as we report here, but also race-related measures such as race stigma consciousness (Pinel 1999), race rejection sensitivity (Mendoza-Denton et al. 2002), racial discrimination on campus, and race-based stereotype threat. A promising measure that should also be included and integrated

into the theoretical model is dual identification or identity compatibility (Ahlqvist et al. 2013; Rosenthal et al. 2013). Based on prior research, women who view their gender identity as compatible with their science or STEM identity are less likely to disengage from the domain after experiencing threat (Baysu et al. 2011). This line of research should be extended to race, examining how integration of gender, race, and science identities serves as a protective factor against the negative effects of threatening academic environments.

In addition to more thoroughly investigating the application of the model with racial minority women, the model should be tested in other contexts like organizations and workplaces. Research on stereotype threat has been conducted in workplace settings and indicates similar negative effects of threat on performance as we see in educational contexts (see Casad and Bryant 2016 for a review). Although the majority of research on women in STEM has been conducted with college students in university settings, a growing both of research has assessed the experiences of women in STEM careers inside and outside academia (Ceci et al. 2014; Hall et al. 2015). In this way, interventions can be developed and tailored to university and workplace contexts.

Theoretical Implications

Ultimately, the experience of women in STEM majors is complex. Whereas prior research often examined a partial combination of relevant variables in isolation, the model we tested herein provides empirical support for a cross-sectional test of the full theoretical model proposed by Inzlicht and colleagues (2009). This model allows better understanding of the affective and cognitive mechanisms experienced by women in STEM majors, which may ultimately influence academic outcomes including persistence. A theoretical implication of this study is that models of women in STEM's educational experiences should consider similarities and differences among subgroups of women, for example STEM subfield and race. Recently, there has been a call for greater specificity in examining STEM fields by focusing on nuances within subfields (Mann and DiPrete 2013; Sax et al. 2010). We know gender disparities in representation are greater in some subfields than in others, but we do not fully understand why.

One reason suggested by the present results is the degree of women's representation in the field, which can influence perceptions of threats in educational environments (Casad et al. 2018, unpublished data). Many of the model paths were stronger for women in subfields with fewer women. Another possibility is the fewer number of women and racial minority faculty in subfields of STEM who could serve as role models (Casad et al. 2018, unpublished data; Chen and Soldner 2014). When models do not take race into account, the results may be underestimating the effects of environmental threat on racial minority students' educational and psychological outcomes.

There also are other contextual factors that play a role in women's experiences in STEM such as socioeconomic status (Chen and Soldner 2014) and college generational status (Tibbetts et al. 2016). The challenge for researchers will be to gather large and diverse samples to allow for tests of these meaningful comparisons.

Practice Implications

Our results highlight key psychological and educational variables that predict women STEM majors' disengagement from STEM, which is useful information to prevent attrition among women STEM majors. The results can be used by educators and practitioners to inform development of interventions to enrich the experiences of women and reduce attrition in STEM. Here we discuss and test the model within an education context, however, the model is applicable in other domains including the workplace (see Casad and Bryant 2016) and healthcare (see Bird and Bogart 2001). For example, given the relation between rejection sensitivity (vigilance) and perception of environmental cues (campus climate), it is critical that universities, organizations, and workplaces are routinely assessed for climate within STEM.

Because many of the cues of identity threat and identity safety are subtle, such as physical spaces (e.g., Cheryan et al. 2009), educators and practitioners interested in developing interventions should become familiar with research and interventions on social identity threat (see Casad and Bryant 2016 and Casad et al. 2018, for a review). For example, office or classroom décor that is perceived as masculine (e.g., Geeky pop culture; bikini calendars) can signal to women that they do not belong (Cheryan et al. 2009). Further, common areas and lobbies should have neutral décor and communicate a diverse and inclusive environment, for example through selection of diverse artwork and magazines (Cohen and Garcia 2008). Institutions of higher education often display photos of prominent figures from the university, but if they depict mostly older, White men, women and racial minorities can feel excluded. Educational settings that promote cues of identity safety can foster a sense of belonging, which will increase students' engagement and performance (Good et al. 2012; London et al. 2014; see Casad and Bryant 2016 and Casad et al. 2018 for additional recommendations).

Our results indicate that future interventions should target women in male-dominated subfields such as engineering, physics, and computer science because these women may be more vulnerable to the negative effects associated with threatening environments (Casad et al. 2018, unpublished data). Women in female-dominated fields like biology may not perceive their environments as threatening due to parity of genders in these majors. This difference further highlights the importance of gender representation as a critical cue in appraising one's environment as safe or threatening (Inzlicht and Ben-Zeev 2000).

Effective interventions can benefit all women regardless of a major's gender-typing and race-typing, although women in male-dominated STEM majors and racial minority women may benefit more from such interventions. Based on the results we present here, interventions focusing on campus (or workplace) climate, stereotype threat, and perceived control seem to be most critical. Multiple effective interventions to reduce stereotype threat have been developed and tested, including valuing diversity, wise feedback, organizational mindsets, reattribution training, reframing the task, values-affirmation, utility-value, belonging, communal goal affordances, interdependent worldviews, and teaching about stereotype threat (for reviews see Casad and Bryant 2016; Casad et al. 2018; Harackiewicz and Priniski 2018; Walton et al. 2015). Interventions targeting implicit intelligence theories (Lin-Siegler et al. 2016) and self-efficacy (Dennehy and Dasgupta 2017) are effective in increasing academic perceived control and reducing academic disengagement. Interventions targeting implicit intelligence theories encourage students to view intelligence as malleable, which increases their perception that academic achievement is based on hard work and effort rather than on innate ability (Lin-Siegler et al. 2016). Research with women and racial minority students in STEM shows gains in self-efficacy, and relatedly perceived control, after students participate in intensive, meaningful research experiences in STEM (Hernandez et al. 2013; Woodcock et al. 2016). These approaches show promise in addressing the risk factors for academic disengagement and lower self-esteem discussed in our study.

Another area for intervention is mentoring programs, which may be especially important for women who show heighted gender rejection sensitivity. When women STEM students are exposed to positive role models, their academic aspirations are enhanced (Lockwood and Kunda 1997) and their self-reported abilities and measured performances increase (Marx and Roman 2002). Research indicates when competent female role models are present, women STEM students experience a boost in performance (McIntyre et al. 2005). Female role models also increase identity compatibility and sense of belonging (Rosenthal et al. 2013). Because women are underrepresented in many STEM subfields, having role models becomes critically important. Unfortunately, the fields in which women STEM students are underrepresented are also fields in which women STEM faculty are underrepresented (Nelson and Rogers 2003). Ultimately, a major intervention for educational institutions is to increase the representation of women and racial minority students and faculty in STEM fields.

Conclusions

Educators, policymakers, and researchers are interested in identifying why U.S. women are consistently underrepresented in STEM fields despite women's higher baccalaureate

completion rates. In our study, we argue that the variables and relations tested in the model of threatening academic environments can help explain women's underrepresentation in STEM fields. Further, we document that the strengths of relations among the variables in the model differ for subgroups of women in STEM, including underrepresented women in male-dominated majors and racial minority women. As predicted, our model was stronger for women in STEM who are particularly vulnerable to stigma and negative outcomes including women in male-dominated STEM subfields and racial minority women. Overall, the results suggest adequate fit of the data to the hypothesized model, providing the first known cross-sectional test of the theoretical model in its entirety. As we outlined previously, our results have implications for theory, future research, and practice. Our results highlight key psychological and educational variables that predict women STEM majors' disengagement from STEM, which can be used to develop interventions to reduce attrition among women in STEM education and careers.

Compliance with Ethical Standards

The research was conducted in compliance with APA's ethical standards and the study was approved by an Institutional Review Board at the authors' institutions.

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