**Stereotype Threat in High School Classrooms:
How It links to Teacher Mindset Climate, Mathematics Anxiety, and Achievement**

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Abstract

As stereotype threat was initially examined in the tradition of experimental research, the effects of stereotype threat have often been tested by temporarily manipulating social identity threat mainly among college students. To extend the literature to adolescents' naturalistic experience of stereotype threat, we examined 9th grade adolescents' stereotype threat using National Study of Learning Mindsets data ($n \sim 6,040$; 48.5% girls). Black and Latino boys experienced higher levels of stereotype threat in high school mathematics classrooms, as compared to black/Latino girls and white peers. When students perceived their teachers to create fixed mindset climate, students experienced greater stereotype threat. Stereotype threat, in turn, negatively predicted later achievement via heightened anxiety among black/Latino boys and white girls. The findings highlight the importance of forming mathematics classrooms that cultivate growth mindset and minimize the threat to students' social identity.

Keywords: stereotype threat, mindset, implicit theories, classroom climate, anxiety, mathematics achievement

Stereotype Threat in High School Classrooms:

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In the United States, women and black/Latinx adults are underrepresented in mathematics-reliant fields, such as physics, engineering, or economics (Cheryan et al., 2015; Skibba, 2016; Xue & Larson, 2015), even though obtaining a career in these fields often yields a high salary and a prestigious job (Berry, 2018; U.S. Bureau of Labor Statistics, 2020). Stereotype threat—situational predicament where individuals experience the risk of confirming negative stereotypes associated with their social positions (Spencer et al., 1999)—has been suggested as a psychological explanation for the underrepresentation of women and individuals of color in these fields. Many empirical studies have shown that stereotype threat undermines performance (see Nguyen & Ryan, 2008, for review).

Since the stereotype threat effect was initially tested in an experimental setting (Spencer et al., 1999; Steele & Aronson, 1995), researchers have tested the debilitating effects of stereotype threat on achievement by eliciting temporal social identity threat using manipulated situational cues in a laboratory with a relatively small sample of college students (see Nguyen & Ryan, 2008, for review). Relatively few studies have examined adolescents' naturalistic experience of stereotype threat in a high school classroom (e.g., Dinella, 2004). In addition, stereotype threat research mostly focused on the comparisons between black/Latinx participants to their white counterparts or the comparisons between white female participants and their white male counterparts (see Aronson & McGlone, 2009; Nguyen & Ryan, 2008, for review). Studies rarely, if ever, examined black/Latinx female participants to black/Latinx male participants, even though naturalistic stereotype threat may have different implications at the intersection of students' gender and racial/ethnic backgrounds (see Cole, 2009). For example, boy's

mathematics ability is not negatively stereotyped, but black boys' academic ability tended to be more negatively stigmatized than their female peers (Chavous et al., 2004; Swanson et al., 2003).

To address the gaps in the literature, the current research examined adolescents' naturalistic stereotype threat using a sample that represents the U.S. population of 9th grade students in regular public high schools. Furthermore, we examined adolescents' naturalistic experience of stereotype threat in their mathematics classrooms and their correlates at the intersection of race/ethnicity and gender.

Stereotype Threat and Achievement

The effects of societal stereotypes on individuals' performance has been mostly studied in laboratory settings where experimenters manipulated the participants' stereotype threat by using ability diagnostic languages or mentioning potential gender or racial/ethnic differences among the test takers (e.g., Spencer et al., 1999; Steele & Aronson, 1995). Later, several field studies examined individuals' naturalistic stereotype threat or social position-based rejection sensitivity in the context of college education (e.g., Woodcock et al., 2012). We first reviewed laboratory studies that experimentally manipulated stereotype threat. We then reviewed field studies that measured naturalistic stereotype threat and their associations with attitudes and achievement.

Manipulated Stereotype Threat

The stereotype threat research has shown that members of a negatively stereotyped social group may underperform on a diagnostic task due to situational cues that bring about their worries over confirming a negative stereotype about their group (Steele & Aronson, 1995). Several meta-analyses found that stereotype threat impaired test performance of women on a mathematics task ($d = -.36$, Nguyen & Ryan, 2008; $d = -.24$, Picho, 2013) and that of black and

Latinx participants on an academic or intellectual task ($d = -.43$, Nguyen & Ryan, 2008). When including only studies on adolescents' gender stereotype threat, a meta-analysis found the effect size to be slightly diminished ($g = -.22$; Flore & Wicherts, 2015). The majority of these studies, if not all, were conducted in a laboratory setting where participants' stereotype threat was experimentally manipulated.

Experimental manipulations of stereotype threat have an indisputable advantage in internal validity or causal inference (Cozby & Bates, 2018). However, the prevalent use of lab-based designs limits external validity when trying to understand the implications of adolescents' naturalistic stereotype threat. A large portion of high school mathematics grades reflects low-stake assignments such as homework or exercises rather than high-stakes standardized tests. In contrast, stereotype threat effects have often been observed with a test that can be perceived as diagnostic or high-stakes. That is, it is yet unclear whether naturalistic stereotype threat indeed translates into real-life outcomes or outcomes that are actually meaningful to individuals, such as school grades (Flore et al., 2018; Stoet & Geary, 2012; Wicherts, 2005). Noticing this gap, Stoet and Geary (2012) concluded that "although stereotype threat may affect some women, the existing state of knowledge does not support the current level of enthusiasm for this as a mechanism underlying the gender gap in mathematics" (p. 93). In other words, it is ambiguous whether adolescents, especially females and/or black and Latinx youth, experience stereotype threat in a regular mathematics classroom similar to a lab setting and whether this experience would negatively relate to their mathematics grades.

Naturalistic Stereotype Threat

Extending the initial laboratory work on temporary stereotype threat, a few studies have examined individuals' naturalistic concerns about negative stereotypes in field studies based on

the rejection sensitivity model (Mendoza-Denton et al., 2002). The rejection sensitivity model posits that individuals with greater sensitivity or concern over rejection based on their group membership may experience decreased motivation and lowered performance in the relevant domain. Based on the rejection sensitivity model, previous field studies examined the negative implications of rejection sensitivity on educational attitudes and achievement among female college students who were majoring in a math-related subject (e.g., Ahlqvist et al., 2013; London et al., 2012) or African American and Latinx students who studied at a university with predominantly white students (e.g., Mendoza-Denton et al., 2002, 2008; Woodcock et al., 2012). The results showed that women (in a math-related domain) and students of color (in a math-related domain and/or a predominantly white university) experienced greater stereotype threat (Cheryan et al., 2020; Mendoza-Denton et al., 2002), which in turn led them to experience diminished motivation (London et al., 2012; Woodcock et al., 2012), decreased belongingness or identification (Ahlqvist et al., 2013; Mendoza-Denton et al., 2008), avoidance of opportunities (London et al., 2012; Woodcock et al., 2012), and poorer grades than their peers (Ahlqvist et al., 2013; Mendoza et al., 2002).

The aforementioned studies, however, all focused on students who were in college and/or already identified with mathematics. Students' experience of stereotype threat does not arise in a vacuum. Stereotype threat is a "situational predicament" (Spencer et al., 1999, p. 6). That is, environmental cues and organizational cultures affect individuals' experience of stereotype threat and belongingness (e.g., Canning et al., 2020; Murphy et al., 2018; Murphy & Taylor, 2011). High school mathematics classrooms have vastly different characteristics than college classrooms (e.g., teacher-student relationships, teaching methods, classroom culture; Cherif & Wideen, 1992) and adolescents' experiences in high school mathematics classrooms carry

significance because the experiences can set trajectories of young individuals' educational choices (e.g., advanced course taking, college major) and career decisions (Riegle-Crumb, 2006; Seo et al., 2019). However, to our knowledge, only a few studies have examined adolescents' naturalistic stereotype threat in their authentic mathematics classroom environment (Dinella, 2004), and no study has examined the issue using the national data that represents the U.S. public high school. The current study examined adolescents' naturalistic stereotype threat using the nationally representative data of U.S. public high school students.

The Process of Naturalistic Stereotype Threat

There have been many studies examining potential mechanisms underlying the effect of stereotype threat on task performance in laboratory studies (see Aronson & McGlone, 2009; Pennington et al., 2016; Schmader et al., 2008; Smith, 2004, for review). Anxiety is one of the most studied mechanisms for the stereotype threat effect (e.g., Gerstenberg et al., 2012; Osborne, 2001). Several studies have found that trying to disapprove a negative stereotype associated with social identity may elicit anxiety given that not only task performance but also self-concept is at risk (e.g., Chung et al., 2010; Laurin, 2013). Furthermore, the rejection sensitivity model focuses on situations where individuals may experience feelings of "anticipatory anxiety" (Mendoza-Denton et al., 2002, p. 899), which suggests that anxiety may play an important mediating role between naturalistic stereotype threat and achievement.

Conversely, several researchers failed to find evidence for anxiety as a mediator (e.g., Mayer & Hanges, 2003; Spencer et al., 1999; Tempel & Neumann, 2014). Spencer and his colleagues (1999), for example, found that anxiety was not a statistically significant mediator for the effect of stereotype threat on test scores. Rather than concluding that anxiety did not mediate the relation, however, the researchers pointed out the limited statistical power due to having only

34 female undergraduate students in their sample, proposing that future efforts replicate the findings with a larger sample. Such conflicting evidence suggests the need to replicate the findings in a naturalistic setting with large sample.

Teacher Mindset Climate

If stereotype threat is associated with mathematics anxiety and impaired performance, one important question to ask is which characteristics of the high school classroom would predispose adolescents to experience stereotype threat? Previous experimental studies have often manipulated task descriptions to elicit stereotype threat among the participants, such as telling the participants that “women obtain lower scores than males” (Cadinu et al., 2003, p. 272). In naturalistic classrooms, these messages may be delivered not only blatantly like the experimental manipulation but also subtly via teachers’ beliefs and behaviors regarding the malleability of students’ ability. We focused on the classroom climate characterized by teachers’ beliefs and behaviors about the malleability of mathematics ability as an antecedent for adolescents’ experience of stereotype threat.

Implicit theories model (Dweck, 1999; Dweck & Yeager, 2019) suggests that individuals who hold a fixed mindset tend to view personal traits fixed whereas individuals who hold a growth mindset tend to view personal traits malleable. Many empirical studies have documented that individuals with a growth mindset tend to have stronger motivation and persistence through challenges as compared to those with a fixed mindset (Blackwell et al., 2007; Burnette et al., 2013).

Recently, researchers focus on situational cues and environmental characteristics that could promote fixed vs. malleable views on individuals’ traits (Meyer et al., 2015; Murphy & Dweck, 2010; Murphy & Kroeper, 2018; Murphy et al., 2007). For example, in school, a

mathematics teacher may create a fixed mindset climate by displaying beliefs (e.g., some kids are smart and others are not) and behaviors (e.g., liking a few students who are good at math) that send students signals that mathematics ability is unchangeable. Imagine a female student who is in a classroom where her teacher displays this type of beliefs and behaviors. In the fixed mindset climate where innate ability is valued, students would be more likely to be concerned with the stereotypes associated with her gender identity (e.g., “girls are inherently bad at math.”). In contrast, when students perceive their climate to be growth mindset oriented (e.g., teachers believe all students have the potential to succeed), the negative stereotypes associated with her gender identity would not be as bothersome. That is, teacher mindset climate can elicit students’ worries about whether their ability would be judged based on their social identity.

We focused on teacher mindset climate among other aspects of classroom climate. The powerless look for cues from the powerful who determines their outcomes (Fiske, 1993). In classrooms, teachers play the most powerful and authoritative role as they lead and evaluate students. Although teachers are not the only sources for feedback, students heavily rely on remarks and behaviors of their teachers as domain experts to figure out whether they are “cut out” for work or not (e.g., Muenks et al., 2020). As such, students’ perceptions of the mindset climate created by their teachers, namely teacher mindset climate, would likely play a critical role in students’ experience of stereotype threat in their mathematics classrooms.

No research has directly examined this idea of the association between teacher mindset climate and stereotype threat experiences in a high school mathematics classroom, but there has been indirect evidence supporting the notion. For example, Canning and colleagues (2020) found that when faculty members believe that intelligence is fixed, their classroom showed greater racial achievement gaps favoring Asian and white students over black, Latinx, Native

American/Alaska Native, and Native Hawaiian/Pacific Island students. Reich and Arkin (2006) illustrated that individuals experienced self-doubt when they believed that evaluators had a fixed mindset. Muenks and colleagues (2020) found that college students' perceptions of their professors' mindset influenced college students' psychological vulnerability, such as greater negative affect or evaluative concerns. Taken together, the empirical evidence proposed the possibility that a teacher's fixed mindset climate may set the stage for students' experience of stereotype threat in a high school mathematics classroom.

The Joint Consideration of Race/ethnicity and Gender

Stereotype threat research focused on the comparisons between black/Latinx participants to their white counterparts or the comparisons between white female participants and their white male counterparts (see Aronson & McGlone, 2009; Nguyen & Ryan, 2008, for review). Studies rarely examined black/Latinx female participants to black/Latinx male participants. Naturalistic stereotype threat, however, may have different implications at the intersection of students' gender and racial/ethnic backgrounds (see Cole, 2009). For example, male students' gender identity itself is not associated with the negative mathematics stereotypes or even associated with positive mathematics stereotypes (i.e., stereotype boost: Shih et al., 2011). In contrast, researchers also have shown that black/Latino male students are more negatively stigmatized than black/Latino female students in naturalistic settings (Chavous et al., 2004; Stephens-Davidowitz & Pabon, 2017; Swanson et al., 2003). For example, black boys are much more likely to be labeled as unruly or at risk as compared to their female peers or white boys (Ferguson, 2000). It is unclear at this juncture how adolescents' diverse social positions would interplay in their experience of stereotype threat in high school mathematics classrooms (e.g., Would black/Latino male students experience less stereotype threat than their female peers or

experience great stereotype threat than their female counterparts?). Thus, we examined adolescents' experience of stereotype threat in their high school mathematics classrooms by race/ethnicity $\times$ gender.

The Present Research

The present research answered three research questions. The first asked whether students experience different levels of stereotype threat in their mathematics classrooms based on their social identity. Regarding racial/ethnic differences, we hypothesized black and Latinx youth would experience greater stereotype threat than white youth. Regarding gender difference, we hypothesized that black/Latino boys would experience greater stereotype threat than black/Latina girls based on the research evidence showing the prevalent negative stereotypes surrounding young men of color in the United States (Knight, 2015). For white students, we expected that girls would experience greater stereotype threat than boys. As a supplemental analysis, we also conducted other group comparisons (e.g., black/Latinx boys vs. white girls), but, due to the lack of prior empirical evidence or theoretical discussion, this analysis is explorative.

The second research question was the extent to which teacher mindset climate was associated with students' experience of stereotype threat in that classroom. Based on previous research suggesting that classroom climate that influences students' experience is students' subjective experiences of their classrooms, rather than some objective reality, we focused on adolescents' perceptions of mindset climate (Patall et al., 2017). Based on the cues hypothesis (Murphy et al., 2007), we expected that would experience greater stereotype threat in their high school mathematics classrooms where their teachers send signals that mathematics ability is fixed. We expected that teacher mindset climate would play a more significant role in the experience of stereotype threat among adolescents with more negatively stereotyped social

identity (e.g., black/Latinx boys) than those with positively stereotype social identity (e.g., white boys).

Our final research question was whether there was an association between adolescents' naturalistic stereotype threat and achievement in U.S. high school mathematics classrooms and whether this association was mediated by mathematics anxiety. Based on the rejection sensitivity model (Mendoza-Denton et al., 2002), we hypothesized that naturalistic stereotype threat would positively relate to mathematics anxiety, which, in turn, would negatively predict mathematics achievement. We also expected that the association between stereotype threat and mathematics anxiety would be more negative to adolescents with more negatively stereotyped social identity (e.g., white girls) than those with positively stereotype social identity (e.g., white boys).

Methods

Data Source and Participants

Our sample was culled from the National Study of Learning Mindsets (NSLM; Yeager, 2019). During 2015-2016 academic year, 9th grade students from one of 139 randomly sampled high schools in the United States participated in the study. The sample was representative of 9th grade students in a public high school in the United States (Gopalan & Tipton, 2018). Students were randomly assigned to an intervention group and a control group. They were then asked to complete an online survey asking demographic and psychological characteristics right before and several weeks after the intervention (i.e., learning about neural plasticity) or control activities (i.e., reading about localization of brain functions). Students' GPAs in 8th and 9th grades were collected via institutional records.

We included a subsample from the NSLM, which consisted of black, Latinx, and white participants in the control group who did not receive a random assignment of the mindset

program. We focused on participants in the control group because mathematics stereotype threat was measured only after administering an intervention, and we wanted to assess naturalistic stereotype threat that was not influenced by the intervention messages. We focused on black, Latinx, and white participants to facilitate our multi-group analyses because the proportions of other race groups in the dataset were relatively small ($< 5\%$). Further, these three racial/ethnic groups have historically been matched to the three largest racial/ethnic groups in the U.S. (United States Census Bureau, 2018) and the most commonly studied in the stereotype threat literature (see Nguyen & Ryan, 2008, for review). This sample included approximately 6,040 students (6.9% black boys, 6.5% black girls, 13.1% Latinos, 12.3% Latinas, 31.5% white boys, 29.7% white girls). We rounded up all sample sizes to the nearest tenth digit in this paper to prevent deductive disclosure.

Measures

Teacher Mindset Climate

Students' perceptions of teacher mindset climate were measured using five items (e.g., "My math teacher thinks that some kids are smart and other are not," "My math teacher seems to believe that only a few students will understand the hardest problems," "My math teacher seems to like you better if you are good at math"). These items reflect climate-level entity theory of intelligence and encompass both beliefs and behaviors (Murphy & Dweck, 2010, p. 283; Murphy et al., 2018).

Students answered these questions based on a five-point scale from *not at all true* (1) to *extremely true* (5). Values were coded so that higher scores indicated stronger perceptions of a fixed mindset climate. Two items ("My math teacher believes that everybody in my class can be very good at math" (reverse-coded), "My math teacher seems to believe students can't really

change how smart they are.”) was removed because including these items resulted in lower reliability. These items also had a relatively low standardized factor loading in a confirmatory factor analysis ($\beta_s < .50$). All other items had standardized factor loadings above .60. The overall reliability of the three items was $\alpha_{\text{total}} = .75$; $\alpha_{\text{black girls}} = .74$, $\alpha_{\text{black boys}} = .75$, $\alpha_{\text{Latina}} = .75$, $\alpha_{\text{Latino}} = .75$, $\alpha_{\text{white girls}} = .76$, $\alpha_{\text{white boys}} = .75$.

We performed configural (invariant form), metric (invariant factor loadings), and scalar (invariant intercepts) invariance tests to ensure measurement invariance of a latent variable using model constraints and Satorra & Bentler (2001) scaled chi-square difference test. The results of measurement invariance showed that three items of teacher mindset climate showed an adequate measurement invariance across (1) black girls and Latinas, (2) black boys and Latinos, (3) white girls, and (4) white boys (configural vs. metric: Satorra & Bentler $\Delta\chi^2(6) = 11.63$, $p = .07$; metric vs. scalar: Satorra & Bentler $\Delta\chi^2(6) = 10.80$, $p = .10$). The final scalar invariance model's fit indices were $\chi^2(12) = 22.37$, $p = .03$, CFI = .98, RMSEA = .03 [90% CI: .01, .04].

Mathematics Stereotype Threat

Students self-rated their worries and concerns about people's mathematics stereotype in terms of gender and race/ethnicity using two items, including “In math class, how much do you worry that people's judgments of you will be affected by your gender?” and “In math class, how much do you worry that people's judgments of you will be affected by your race or ethnicity?” The items for naturalistic stereotype threat were similar to the items used in prior research (e.g., “In testing situations, I worry that people will draw conclusions about me based on what they think about my ethnic group,” Chung et al., 2010; see also Marx et al., 2005). These items were asked based on a five-point scale from *not at all* (1) to *an extreme amount* (5). The reliability was adequate across different gender and racial/ethnic groups ($\alpha_{\text{total}} = .79$; $\alpha_{\text{black girls}} = .81$, α_{black}

boys = .79, $\alpha_{\text{Latina}} = .77$, $\alpha_{\text{Latino}} = .83$, $\alpha_{\text{white girls}} = .71$, $\alpha_{\text{white boys}} = .84$).

Mathematics Anxiety

Students' mathematics anxiety was assessed using an item, "In general, how much does the subject of mathematics in high school make you feel nervous, worried, or full of anxiety?" based on a five-point Likert scale from *not at all* (1) to *an extreme amount* (5). Anxiety has often been measured with a single item with evidence for adequate validity and reliability in the extant literature (Goetz et al., 2010, 2016; Seo & Patall, 2020). Research has also suggested that asking participants to respond to a longer measure of emotion could introduce unnecessary reflections and result in the measurement of emotions toward answering the questionnaire (Goetz et al., 2010, 2016). Accordingly, the NSLM used a single item to assess students' mathematics anxiety.

Mathematics Achievement

Some schools completed the stereotype threat survey in the fall semester of 9th grade, and other schools completed the survey in the spring semester of 9th grade. In line with the pre-registration of the previous study utilizing same data (Yeager et al., 2019) and to ensure temporal precedence of the focal variables, we used the institutional records of the students' mathematics course GPA in 9th grade as an outcome for students who participated in the study in the fall semester. For students who participated in the study during their spring semester of 9th grade, we included only their spring semester mathematics course GPA as an outcome.

Covariates

To control for potential confining effects, we included previous mathematics achievement, mathematics course level, and family socioeconomic status as covariates. *Previous mathematics achievement* was measured based on the institutional records of students' mathematics grades in 8th grade. *Mathematics course level* was also assessed based on the

institutional records of students' mathematics course taking in 9th grade. Course level was coded so that higher scores represent more challenging courses (1 = Basic mathematics, 2 = Pre-algebra, 3 = Algebra 1, 4 = Geometry, 5 = Algebra 2, 6 = Other advanced math, 7 = Pre-calculus/Calculus). Finally, *family socioeconomic status* was measured based on mother's highest education level (1 = Did not finish high school, 2 = Finished high school, 3 = Took some college courses, 4 = Associate's degree, 5 = Bachelor's degree, 6 = Master's degree, 7 = Doctorate degree) and free or reduced lunch status (0 = Not receiving free or reduced lunch, 1 = Receiving free or reduced lunch; Domina et al., 2018).

Data Analyses

We estimated structural equation models (SEM) in Mplus 8 (Muthén & Muthén, 1998-2017). To answer the first research question, we took the multiple indicators and multiple causes (MIMIC) approach (Hancock, 2001). The model included race/ethnic and gender identity (i.e., black/Latina girl, black/Latino boy, white girl, white boy) as a predictor for the experience of stereotype threat in high school mathematics classrooms. We included Grade 8 mathematics grade as a covariate.

To answer the second and the third research questions, we included teacher mindset climate as a predictor for stereotype threat. We also included mathematics anxiety as an outcome of stereotype threat, which in turn predicted mathematics achievement. Finally, we controlled for previous mathematics achievement, mathematics course level, mother's education, and free or reduced lunch status as control variables. This model is graphically depicted in Figure 1.

To compare path coefficients across gender and racial/ethnic identity groups, we conducted Satorra and Bentler (2001) scaled chi-square difference tests for different patterns of path coefficients to examine whether the difference was statistically significant. To maximize the

statistical power while preventing the inflated type I error rate due to multiple comparisons across groups, we combined black and Latinx students and created four different race/ethnicity $\times$ gender groups, including (1) black girls and Latinas; (2) black boys and Latinos; (3) white girls; and (4) white boys. The correlations were relatively similar among black and Latinx students (e.g., correlations between stereotype threat and mathematics anxiety were .16 for both black and Latina girls), providing support for the decision to merge the two groups.

The model fit was evaluated via the Comparative Fit Index (CFI; values $\geq .95$ for adequate fit, Hu & Bentler, 1999) and root mean square error of approximation (RMSEA; values $\leq .06$ for adequate fit). We used a robust maximum likelihood estimator (MLR) to account for the non-normal distribution of mathematics anxiety. Also, we estimated the missing data using the full information maximum likelihood (FIML) estimation (Peugh & Enders, 2004). The nested structure of the data (i.e., students nested within schools) was handled using cluster-robust standard errors (McNeish et al., 2017). Finally, to adjust for over- or under-sampling of a subpopulation, we used a weighting variable that was created based on 9th grade variables.

Results

The Experience of Stereotype Threat Based on Social Identity

Descriptive statistics and intercorrelations of focal variables were presented in Table 1. The MIMIC model found that black/Latino boys experienced the highest level of stereotype threat (black/Latino boys vs. black/Latino girls: $b = .14$, $SE = .08$, $p = .09$, $\beta = .06$; black/Latino boys vs. white girls: $b = .40$, $SE = .09$, $p < .001$, $\beta = .22$; black/Latino boys vs. white boys: $b = .30$, $SE = .09$, $p = .001$, $\beta = .16$), followed by black/Latina girls (black/Latina girls vs. white girls: $b = .26$, $SE = .06$, $p < .001$, $\beta = .14$; black/Latina girls vs. white boys: $b = .15$, $SE = .06$, $p = .01$, $\beta = .08$), white boys (white boys vs. white girls: $b = .11$, $SE = .04$, $p = .01$, $\beta = .06$), and

white girls.

The results of the analyses of individual item showed that the results regarding black/Latino boys' experience of high levels of stereotype threat were driven by both racial/ethnic identity and gender identities. Similar to the results using the total scores of stereotype threat, black/Latino boys experienced a higher level of stereotype threat based on both race/ethnicity and gender as compared to white boys (race/ethnicity: $b = .32$, $SE = .10$, $p = .002$, $\beta = .16$; gender: $b = .13$, $SE = .04$, $p = .002$, $\beta = .27$) and white girls (race/ethnicity: $b = .55$, $SE = .09$, $p < .001$, $\beta = .28$; gender: $b = .12$, $SE = .04$, $p = .01$, $\beta = .25$). There was no statistically significant difference between black/Latino boys and girls on stereotype threat based on their race/ethnicity ($b = .16$, $SE = .09$, $p = .08$, $\beta = .06$) and gender ($b = .05$, $SE = .03$, $p = .14$, $\beta = .12$).

Teacher Mindset Climate, Stereotype Threat, Anxiety, and Achievement

The overall model fit was adequate, $\chi^2(68) = 122.62$, $p < .001$, CFI = .97, RMSEA = .02 [90% CI: .02, .03]. We presented standardized path coefficients of three models in Figure 1.

Across all four racial/ethnic $\times$ gender groups, fixed teacher mindset climate positively had a statistically significant association with stereotype threat after controlling for prior mathematics achievement and socioeconomic backgrounds (black and Latinx boys: $b = .31$, $SE = .05$, $p < .001$; black and Latinx girls: $b = .28$, $SE = .04$, $p < .001$; white boy: $b = .22$, $SE = .04$, $p < .001$; white girl: $b = .16$, $SE = .02$, $p < .001$). The association was weaker for white girls as compared to boys (white boy vs. white girl: Satorra-Bentler $\Delta\chi^2(1) = 5.38$, $p = .02$; black and Latinx boys vs. white girls: Satorra-Bentler $\Delta\chi^2(1) = 38.78$, $p < .001$; black and Latinx girls vs. white girl: Satorra-Bentler $\Delta\chi^2(1) = 3.51$, $p = .06$). We also found that fixed teacher mindset climate had a statistically significant direct association with anxiety among all students (black and Latinx boys: $b = .34$, $SE = .15$, $p = .02$; black and Latinx girls: $b = .27$, $SE = .13$, $p = .04$;

white boys: $b = .47$, $SE = .10$, $p < .001$) except for white girls ($b = .14$, $SE = .18$, $p = .42$). There was no significant difference in the path coefficients across groups (Satorra-Bentler $\Delta\chi^2(3) = 4$, $p = .26$).

Stereotype threat was, in turn, associated with anxiety toward mathematics among black and Latinx boys ($b = .23$, $SE = .08$, $p = .01$) and white girls ($b = .26$, $SE = .10$, $p = .01$) after controlling for prior mathematics achievement and socioeconomic backgrounds. The association between stereotype threat and mathematics anxiety was, however, statistically not significant for black and Latinx girls ($b = .14$, $SE = .11$, $p = .19$) as well as white boys ($b = .09$, $SE = .09$, $p = .32$). For white boys, stereotype threat was directly associated with mathematics achievement ($b = -.11$, $SE = .04$, $p = .01$). For black and Latinx girls, stereotype threat was associated with neither anxiety or achievement ($b = .03$, $SE = .06$, $p = .57$).

Finally, mathematics anxiety was negatively associated with mathematics achievement across all groups (black and Latinx boys: $b = -.27$, $SE = .09$, $p = .003$; black and Latinx girls: $b = -.11$, $SE = .05$, $p = .03$; white boys: $b = -.18$, $SE = .04$, $p < .001$; white girls: $b = -.14$, $SE = .04$, $p < .01$).

Discussion

Adolescents' experience in 9th grade mathematics classrooms plays a crucial role in their persistence in advanced mathematics courses and college entrance (Riegle-Crumb, 2006; Seo et al., 2019). Based on the nationally representative data of 9th grade students, our findings offer a nuanced understanding of how adolescents experience stereotype threat in authentic high school mathematics classrooms. We first showed that adolescents experienced stereotype threat in their mathematics classroom to a different extent based on their social identity. Black and Latino boys experienced the highest level of stereotype threat, followed by black and Latina girls, white boys,

and white girls. The results resonate with recent studies reporting black and Latino boys' experience of systematic racism and discrimination in school (Badger et al., 2018; Landale et al., 2017). Black boys, for instance, receive disciplinary actions at a much higher rate than their white peers (Gregory & Weinstein, 2007; Office for Civil Rights, 2012) and the disciplinary gap is associated with racial stereotypes (Okonofua & Eberhardt, 2015) and county-level rates of explicit racial bias (Riddle & Sinclair, 2019). Accumulation of these negative experiences may further elicit worries about whether their mathematics ability would be judged based on their social identity rather than individual performance. Regardless of whether this threat experience is linked to impaired academic performance, the experience of the threat has a detrimental effect on individuals' physical and mental well-being (Contrada et al., 2000; Paradies et al., 2015). The findings suggest the need to lower youth's experience of threat in mathematics classrooms.

As one way to explain the variability in students' experience of stereotype threat, we examined teacher mindset climate as a potential antecedent. Stereotype threat arises due to the "threat in the air" (Steele, 1997, p. 613). That is, the experience of a threat to one's social identity rises due to situational cues and organizational cultures (Murphy et al., 2007; Murphy & Taylor, 2011). In line with this, we found that when adolescents perceived their teachers to hold fixed mindset beliefs toward students, such as believing that some kids are smart and others are not, the adolescents were more likely to experience stereotype threat in the mathematics classroom. In other words, adolescents' perceptions of the classroom environments and teachers can increase students' experience of stereotype threat in their mathematics classroom even though they are, in many cases, well-intentioned. For example, researchers have shown that teacher practices, like comparing students' mathematics performance to other students' can lead students to experience stereotype threat (von Hippel et al., 2011) even though these practices

may be done with the positive intention to motivate students. If a school wants to reduce students' stereotype threat in the mathematics classroom, it would be advisable to identify specific teaching practices that increase students' perceptions of a fixed mindset classroom.

Fixed mindset climate was also associated with adolescents' feelings of anxiety toward mathematics among black/Latinx students and white boys. This finding extends the prior research on the role of organizational (Murphy & Dweck, 2010; Murphy et al., 2018) and teacher (Muenks et al., 2020) mindset, which showed that teacher or organizational mindset influences college students' self-concepts and psychological vulnerability. Considering that students' experience in high school mathematics plays a crucial role in students' future decisions such as advance mathematics course taking, college entrance, and career choice (Riegle-Crumb, 2006; Seo et al., 2019), we suggest the need to mitigate the forming of a fixed mindset climate in high school mathematics classrooms.

In addition, our findings also showed that stereotype threat predicted lowered mathematics achievement via anxiety among black/Latino boys and white girls. The findings critically extend the literature on stereotype threat (Steele & Aronson, 1995), which was mostly conducted in an experimental condition, and the rejection sensitivity model (Mendoza-Denton et al., 2002), which was mostly applied to explain college students' experiences. We showed that naturalistic stereotype threat might have negative implications for achievement even in adolescence.

It is notable that we found the mediating role of anxiety only among black/Latino boys and white girls and not among black/Latina girls and white boys. This finding provides only partial support for the prior hypothesis that posits anxiety as an underlying mechanism for the effect of stereotype threat (Gerstenberg et al., 2012; Osborne, 2001). For white boys, it makes

sense that their worries about whether their mathematics ability would be judged based on their social identity were not associated with anxiety. The burden of proof hypothesis (Brown & Josephs, 1999) suggests that white boys may also experience identity threat due to the positive stereotype associated with their academic ability, but it may manifest in a different form from black or Latinx youth's experience of stereotype threat. For white boys, they feel pressure to confirm the positive stereotype associated with their gender and racial/ethnic identity, especially in an environment where there is an emphasis on the task's ability to diagnose "exceptional ability." The pressure to meet the expectation may lead to stress rather than anxiety.

For black/Latina girls, anxiety did not mediate the association between stereotype threat and mathematics achievement. Moreover, stereotype threat also did not directly predict later mathematics achievement after controlling for prior achievement. The results suggest that the experience of stereotype threat was not associated with impaired mathematics achievement among black/Latina girls. The findings perhaps explain why some researchers found null or smaller findings of stereotype threat effect with samples of black participants (e.g., Finnigan & Corker, 2016). Given the large sample size of the current research, the findings are unlikely due to statistical power. One potential reason may be due to their tendency to respond to negative experiences in adaptive ways. Research shows that black and Latina girls tend to cope with negative events better than their male peers (Romero et al., 2014, Chapter 2; Thomas & Rodgers, 2009). This provides an important insight into black and Latina girls' resilient coping.

Another interesting result was that teacher mindset climate was less strongly associated with the experience of stereotype threat and feeling of anxiety among white girls. Cole and colleagues (1997), for example, showed that girls' self-perceptions mostly relied on parents' appraisals of them in third grade and peers' appraisals of them in sixth grade. Furthermore,

Putnick and colleagues (2019) showed in their study of European American children that teachers' beliefs about children's competence did not predict later performance, whereas parents' assessments of child competence did. Although the study did not differentiate the patterns of the results by children's gender, perhaps the results were driven by the relative importance of teachers, parents, and peers in white girls' attitudes toward mathematics. This is not to say that teachers do not play a role in white girls' experience of stereotype threat and mathematics anxiety. In fact, previous studies have shown that teachers play an important role in white female students' experience of stereotype threat (Tomasetto et al., 2011) and anxiety (see Gunderson et al., 2012, for review) and our findings show that teacher mindset climate predicted female adolescents' experience of stereotype threat. Yet, the relative importance of teacher mindset climate in white girls may be smaller as compared to their peers.

Finally, it is important to caution that the correlational nature of the current data prevents any causal claims about stereotype threat. We utilized the correlational data given our interest in naturally developed concerns about mathematics stereotypes among adolescents. Correlational research is useful because it allows the identification of youth at risk and the prediction about future outcomes (Stanovich, 2007). In addition, we controlled for the key variables that may pose confounding effects, namely previous achievement and socioeconomic status, which enhanced the credibility of the findings. It is, however, important not to make any causal inferences until experimental and cross-lagged longitudinal evidence accumulates.

Conclusion

As stereotype threat was initially examined in the tradition of experimental research, the effects of stereotype threat have often been tested by temporarily manipulating social identity threat mainly among college students. Our research extends the literature by examining

adolescents' naturalistic experience of stereotype threat in an authentic high school classroom and how the experience was associated with the classroom climate, anxiety, and achievement. Our findings show that adolescents, regardless of their race/ethnicity and gender, experienced social identity threat, especially in the fixed mindset teacher climate. Furthermore, young individuals' experience of identity threat in their classroom might prevent them from fully reaching their potentials, especially among black and Latino boys. We hope the findings of this study contribute to the body of literature that sheds light on the negative outcomes of social identity threat for bright young individuals' achievement and urges readers to see the need to change the environment to lessen youth's concerns about mathematics stereotypes in the classroom.

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(a) black and Latinx boys/girls

(b) white boys/girls

Figure 1. The associations of mathematics teacher mindset climate to stereotype threat, anxiety, and achievement. ns = statistically not significant. We included previous mathematics achievement, mathematics course level, mother’s education level, and free or reduced lunch status as covariates. These covariates were omitted in the figure for graphical simplicity.

Table 1.
Descriptive Statistics by Racial/Ethnic $\times$ Gender Groups and Correlations

	Mean (Standard deviation)				Bivariate correlation						
	Black boy/ Latino	Black girl/ Latina	White Boy	White Girl	1	2	3	4	5	6	7
1. Fixed mindset climate	2.19 (0.85)	2.07 (0.87)	2.05 (0.85)	1.99 (0.79)	---						
2. Stereotype threat	1.88 (1.02)	1.71 (0.93)	1.57 (0.86)	1.46 (0.77)	.33***	---					
Gender identity threat	1.83 (1.08)	1.71 (1.05)	1.56 (0.94)	1.58 (0.99)	---	---					
Racial/ethnic identity threat	1.88 (1.12)	1.73 (0.99)	1.56 (0.94)	1.33 (0.77)	---	---					
3. Anxiety	2.50 (1.14)	2.96 (1.22)	2.45 (1.17)	2.79 (1.27)	.19***	.18***	---				
4. Grade 9 GPA	1.85 (1.25)	2.23 (1.23)	2.30 (1.25)	2.73 (1.22)	-.13***	-.18***	-.19***	---			
5. Grade 8 GPA	2.23 (1.12)	2.58 (1.03)	2.60 (1.15)	3.00 (1.03)	-.10***	-.14***	-.09***	.63***	---		
6. Course level	2.93 (0.83)	2.88 (0.85)	3.22 (0.84)	3.28 (0.85)	-.03*	-.06***	.01	.18***	.12***	---	
7. Mother's education	3.13 (2.73)	3.14 (1.79)	3.97 (1.69)	3.89 (1.63)	-.03	-.06***	-.04	.25***	.23***	.10***	---
8. Free/reduced lunch	0.61 (0.50)	0.62 (0.49)	0.33 (0.47)	0.28 (0.44)	.05**	.10***	-.02	-.29***	-.39***	-.21***	-.36***

Note. GPA = Grade Point Average.

** $p < .01$, *** $p < .001$.