Abstract

Racial stereotypes are salient to Black adolescents and to the academic domain of mathematics; however, few studies have examined the socio-cognitive mechanisms through which racial stereotypes impact math achievement. This 2-year longitudinal study (N = 790 Grade 6, 8, and 10 students during Year 1; 50.7% girls and 49.3% boys) investigated (a) the extent to which the endorsement of positively and negatively biased racial stereotypes predicted Black adolescents' math performance through their cognitive engagement and ability mindset and (b) whether gender and ethnic-racial identity moderated these links. Results suggested that endorsement of negatively biased stereotypes was associated with diminished cognitive engagement and lower math scores across 2 years ($p < .05$). Additionally, adolescents' ethnic-racial identity commitment moderated the negative links between stereotype endorsement and math cognitive engagement in Year 2 ($p < .05$). When considering the mediating role of math ability mindsets, the endorsement of both positively and negatively biased racial stereotypes operated on math performance via its links to stronger fixed ability mindset beliefs in both years ($p < .05$). Gender also moderated the effects of racial stereotype endorsement on math mindset beliefs in Year 1 ($p < .01$). This study's findings advance the field's understanding of the psychosocial mechanisms through which racial stereotypes operate, thus enabling educators to develop tailored practices that facilitate equitable access to math learning opportunities.

Keywords: racial stereotype, student engagement, ability mindset, academic achievement, math learning

Racial Stereotype and Black Adolescents' Math Achievement: Unpacking the Socio-Cognitive Mechanisms

Introduction

Despite decades of reform, the United States continues to struggle with racial disparities in math education (National Science Foundation, 2018). Although Black students consistently trail their White peers in math performance, they have comparable interests and self-efficacy in math and they are just as likely as White youth to enter STEM majors (Riegle-Crumb et al., 2019). Such disparities highlight the continued salience of racism in math learning, indicating that academic stereotypes and stigmatizing experiences may undermine Black students' math engagement (Martin, 2009; Nasir et al., 2008). Stereotype endorsement can be conceptualized as a conscious belief that an individual's abilities or attributes are based on their social group membership or social identity (Devine, 1989). Black students have reported that they are aware of racist beliefs regarding who can be good at math and they may even endorse these stereotypes when ascribed to them personally (Munter & Haines, 2019).

However, few studies have investigated how or through what socio-cognitive mechanisms the endorsement of racial stereotypes impacts students' math achievement or which sociocultural factors may mitigate such effects. In particular, the developmental period from fifth to twelfth grade is marked by an increased endorsement of math stereotypes among adolescent students (Rowley et al., 2007) and the endorsement of math stereotypes influences student engagement and ability mindset beliefs (Wang et al., 2022). These socio-cognitive outcomes are strong predictors of math performance and are highly responsive to social contexts; hence, both cognitive engagement and ability mindset may serve as potential mediators of the links between racial stereotype endorsement and math performance (Rowley et al., 2007; Wang et al., 2016). In

addition, stereotype threat literature and learning theories have suggested that social identities (e.g., gender, race/ethnicity) shape the way adolescents perceive and react to their educational contexts (Martin, 2007; Steele, 1997). Research on gendered academic learning has revealed that Black girls and Black boys both face unique challenges due to racial and gender stigmas (Rowley et al., 2007). For instance, Black girls may contend with a double minoritized status (i.e., gender and race), whereas Black boys may experience threats to their social identity as hypervisible members of their ethnic-racial group (Purdie-Vaughns & Eibach, 2008). However, ethnic-racial identity development may impede or confer protection in the context of race-based adversity (Yip, 2014; Yip et al., 2019).

The overarching goal of this study was to identify the extent to which endorsement of racial stereotypes (i.e., positively or negatively biased) was linked to math performance through socio-cognition in math learning (see Figure 1 for the conceptual model). With neutral beliefs (i.e., the belief that Black people are no better or worse than White people in math) as the reference, Black adolescents with positively biased in-group stereotypes may believe that Black people are better than White people in math whereas Black adolescents with negatively biased in-group stereotypes may believe that Black people are worse than White people in math. Additionally, we sought to investigate the mediating roles of cognitive engagement and mindset beliefs in the longitudinal link between Black adolescents' stereotype endorsement and their math performance. Lastly, we tested whether this longitudinal connection differed by adolescents' gender and ethnic-racial identity. Thus, this study was designed to advance the field's understanding of the psychosocial mechanisms through which racial stereotypes operate, thus enabling educators to develop tailored interventions and practices that facilitate equitable access to math learning opportunities.

The Socio-Cognitive and Macrostructural Roots of Stereotype Beliefs

Stereotypes are shared, societally prevalent beliefs about the characteristics of specific groups that underlie narratives about what is typical, common, or possible for a particular group (Bigler & Liben, 2006). Multiple socio-cognitive processes shape the development of stereotypes. For example, stereotypes are born out of a person's natural tendency to engage in self-categorization as a member of a specific ethnic-racial group, which in turn shapes their self-concept and sense of in-group affiliation and affinity (Barrett & Davis, 2008; Pauker et al., 2016). This internalization of one's social identity—also referred to as social group membership—can lead to depersonalization of the self or self-stereotyping in which a person minimalizes their individual personal attributes and elevates the salience of group-based characteristics. Through these dual processes, children tend to develop positive in-group biases and negative out-group prejudices. Developmentally, high levels of in-group favoritism have been shown to emerge in early childhood, but by middle childhood, the intensity of positive in-group biases decreases and eventually plateaus (Wilkerson, 2020).

Importantly, these processes do not unfold in an ecological vacuum. They are context-dependent, and the level of in-group versus out-group favoritism as well as the content of in-group versus out-group biases are molded by the macrostructural context, including the downstream consequences of historical processes of social and racial stratification (Barrett & Davis, 2008; Pickering, 2004). These stratification processes produce cultural racism—the ideological worldview that stigmatizes (and ascribes inferior status to) some racial/ethnic groups while privileging (and ascribing superior status to) other racial/ethnic groups (Pickering, 2004). In turn, cultural racism provides the rationale for how systemic, institutional, and interpersonal discrimination manifests in pervasive negative stereotypes about stigmatized racial/ethnic

groups. In the United States, anti-Black cultural racism has been a prevailing societal force undergirding negative stereotypes about Black youth's academic ability (Wilkerson, 2020).

Due to their pervasiveness, stereotypes can inform the implicit and explicit attitudes and behaviors of individuals and the institutions they construct, including schools (Del Toro & Wang, 2023). Scholarship on stereotype threat has theoretically and empirically delineated the ways in which minoritized youth's awareness of pernicious beliefs about their racial/ethnic group's academic abilities can undermine their academic performance, interest, and motivation (Steele, 1997; Steele & Aronson, 1995). If stereotype awareness alone can undermine academic functioning, the actual endorsement of academic stereotypes may lead to even more deleterious academic outcomes. Research has also suggested that associations between stereotype beliefs and academic cognitions, behaviors, and achievement are stronger in domains such as math, which are often perceived as requiring a special (or innate) intellectual talent or ability. For these reasons, it is crucial to understand the mechanisms through which stereotype awareness and endorsement shape youth's math performance over time.

Stereotype Endorsement, Socio-Cognition, and Academic Achievement during Adolescence

The integrative development-in-sociocultural-context model—a model focusing on youth's engagement in learning—outlines the processes through which stereotype endorsement can affect adolescents' academic performance via their socio-cognition (Wang et al., 2019). This theoretical framework underscores the importance of youth's responses to stressors in their proximal environments, asserting that social cognitions shape youth's behaviors and attitudes. Specifically, youth's interpretation of environmental stressors (e.g., discrimination, stereotype, prejudice) may produce habitual response patterns that become ingrained in their coping styles and strategies (Wang et al., 2019). Stereotype endorsement can be understood as an individual's

beliefs about others' inherent abilities within a specific domain based on their social group membership (Devine, 1989). Endorsement of racial academic stereotypes, regardless of content, may lead Black adolescents to disengage from academic tasks as they may attribute learning outcomes to the presence or absence of inherent abilities rather than exertion of effort or use of effective learning strategies.

In situations wherein adolescents seek to either disprove negative stereotypes or prove positive stereotypes, stereotype endorsement can be demotivating whereas hyper-vigilance may increase youth's cognitive load (Schmader et al., 2008). Thus, both positively and negatively biased stereotypes are likely associated with diminished cognitive engagement and fixed mindset beliefs that attribute academic success to innate abilities (Pennington et al., 2016; Wang et al., 2019). Indeed, both White and Black adolescents who endorse gender stereotypes in math have reported lower math interest (Plante et al., 2019) and Black youth have shown lower math cognitive engagement and stronger fixed mindsets when endorsing racial stereotypes in math (Wang et al., 2019). Over time, these socio-cognitive factors (i.e., cognitive engagement and mindset beliefs) may serve as underlying mechanisms through which racial stereotype endorsement undermines Black youth's academic performance.

However, some evidence has indicated that the effect of a stereotype on academic performance may depend on the valence of the stereotype (i.e., positive or negative). For instance, Black adolescents in the US have been found to endorse negative academic stereotypes that position White people as innately better 'math-doers' than Black people (Burnett et al., 2020). Endorsement of this negative stereotype may undermine Black adolescents' cognitive flexibility, attention, and persistence when working on math tasks (Pennington et al., 2016). Indeed, the stereotype threat literature has found that Black students who consciously or

unconsciously hold negative stereotypes about their racial group demonstrate poorer academic performance (Pennington et al., 2016; Steele, 1997). On the contrary, the stereotype boost literature has illustrated that Black students' endorsement of positive stereotypes about their racial group is beneficial for their academic outcomes (Walton & Cohen, 2003). Positive stereotypes about academic ability may buttress racially minoritized students' positive self-perceptions through self-enhancement processes (Rouland et al., 2013). Relatedly, studies have also found that individuals from social groups that are negatively stereotyped in a particular academic domain (i.e., math) show greater cognitive flexibility and improved performance when they think about counter-stereotypes (Crisp et al., 2009; Gocłowska et al., 2013). Given these mixed findings, the impact of positively biased stereotype endorsement on math performance warrants further investigation.

Socio-Cognitive Processes as Mediators

Cognitive engagement and growth mindset are critical socio-cognitive factors shaping youth's math learning trajectories, especially in the educational context of increased expectations for what students should know and be able to do to be adequately prepared for future opportunities (Taningco et al., 2008). Students' cognitive engagement involves personal investment, thoughtfulness, and willingness to put forth mental effort during learning activities (Connell, 1990). Cognitive engagement is especially essential for academic success as students must plan, reflect upon, and evaluate their own learning progress, strategies, and outcomes (Taningco et al., 2008). Not only does cognitive engagement help adolescents perform well in their mathematics classrooms, but it also increases the likelihood of these students pursuing STEM-related college majors and careers (Wang et al., 2017). However, fostering adolescents' cognitive engagement in mathematics poses a challenge to educators as overall math engagement

declines significantly throughout secondary school (Wang & Degol, 2013). This decline has been particularly noticeable in the math engagement trajectories for Black and Latinx students, which has been linked to their experiences with individual and systemic racism (Chouinard & Roy, 2008).

Mindset beliefs—that is, an individual's underlying beliefs about intelligence—create a motivational context that influences students' responses to challenges and struggles associated with academic learning (Dweck, 2012). There are two primary mindsets documented in the literature: the *fixed mindset,* which envisions intelligence as an inherited and unchangeable quality, and the *growth mindset,* which views intelligence as malleable (i.e., intelligence can grow and change over time). Researchers have consistently found that students who adopt growth mindsets tend to show higher academic achievement (Paunesku et al., 2015) and students with growth mindsets are also more likely to engage in difficult tasks and persist after setbacks (Dweck, 2012). Although holding a growth mindset serves as a boon to those who adopt it, adolescents often hold fixed mindsets about math learning that attributes math success to one's innate ability as a 'math person' (Leslie et al., 2015).

Although not specifically focused on racial stereotype endorsement, a growing body of empirical studies have asserted that socio-cognitive factors explain the relation between sociocultural stressors and adolescents' academic underperformance. For example, studies have found that perceptions of ethnic-racial discrimination predict lower engagement in school, which in turn undermines adolescents' academic performance (Brody et al., 2012; Griffin et al., 2017). Other researchers have found that cognitive factors serve as underlying mechanisms through which perceived stress impedes adolescents' performance, although these studies did not investigate sociocultural stressors (Hentges et al., 2019). Furthermore, a series of studies

conducted by Mrazek and colleagues (2018) showed that the cultivation of growth mindset beliefs among participants enhanced their perseverance during difficult tasks and practicing self-control in daily lives. Thus, it is possible that the endorsement of stereotypes foments adolescents' development of fixed mindsets, which in turn can undermine academic performance.

Gender as a Moderator

The integrative development-in-sociocultural-context model also highlights how social identities, such as gender, determine where individuals fall in the social hierarchy. Social identities can confer or exacerbate varying degrees of advantage and disadvantage (Riegle-Crumb et al., 2019; Wang et al., 2019). Multiple studies have found that girls tend to experience pervasive forms of classroom-based sexism that threaten their positive academic adjustment. More specifically, research on math achievement has suggested that, in general, girls are often overlooked in favor of boys in the classroom, are responded to less positively by teachers and peers, and are viewed as less intellectually capable than boys (Cunningham et al., 2013). However, this biased gender dynamic does not seem to apply to Black students. Relative to other boys and Black girls, jointly constructed racial and gender stereotypes often portray Black boys in a more negative light academically and behaviorally (Chavous et al., 2003).

Purdie-Vaughns and Eibach (2008) suggested that women, unlike men, do not fit the prototypical images of Black and White stereotypes. That is, being a woman is synonymous with being a subordinate, socially invisible member of one's own racial group, and this gendered stereotype may allow adolescent girls to escape from many race-based academic stereotypes. In support of this assertion, research has shown that girls consistently outperform boys in most academic domains during the K–12 school years. In particular, Black girls are more likely to

enroll in advanced math courses and have higher test scores than Black boys (National Science Foundation, 2018). Moreover, gender differences in academic outcomes are more pronounced among Black youth than among their White peers (e.g., Black girls' educational advantages on grades; Voyer & Voyer, 2014). Consequently, relative to Black boys, Black girls' academic success might provide protection against the effects of racial stereotypes.

Yet, recent research has complicated the narrative about Black girls' academic functioning. Experimental studies have found evidence of discrimination against Black girls in the ways that teachers and school counselors evaluate their math skills (Copur-Gencturk et al., 2020; Francis et al., 2019). Specifically, Copur-Gencturk and colleagues (2020) found that teachers rated Black (and Latina) girls as having less math ability than minoritized boys or White students (of either gender) when turning in similar work. These biases were most pronounced when teachers had to make more subjective judgments about students' math performance. Similarly, Francis et al. (2019) found that among Black and White boys and girls, Black girls were the demographic group least likely to be recommended for calculus advanced placement by academic counselors, even when their transcripts were identical to their peers. These findings highlight the ways in which Black girls may endure specific forms of gendered racism that imperil their math engagement and achievement.

To our knowledge, only two empirical studies have explicitly examined whether gender moderates the link between adolescents' race-based stereotype endorsement and school outcomes. Evans and colleagues (2011) found that Black boys who rated Black students as less competent in math and science than White students also reported lower academic self-concept, whereas Black girls' racialized perceptions of competence in those domains were unrelated to their academic self-concept. Thus, Black boys who experience discrimination or threats to their

social identity in math and science courses may be more likely to experience diminished academic self-concept. Relatedly, Rouland and colleagues (2013) found that under some conditions, Black girls may confront more pronounced psychosocial and contextual risks than Black boys. Black mothers are more likely to attribute their daughters' failures in math or science to a lack of innate ability (Rouland et al., 2013), which in turn can influence their daughters' mindset beliefs regarding academic performance. Should these girls attribute their performance to their innate ability rather than effort, their levels of academic persistence may decline. Given that boys and girls face unique challenges with respect to racial and gender stigmatization in math learning, we examined whether gender moderated the link between racial stereotype endorsement and math outcomes for Black students.

Ethnic-Racial Identity as a Moderator

Research has shown that in addition to social identity membership, a strong ethnic-racial identity can act as a buffer against racial stigmatization and prejudice (Yip et al., 2019). Ethnic-racial identity is a meta-construct that represents overlapping ethnic and racial identity processes (Hughes et al., 2006; Rivas-Drake et al., 2014). In prior research, the term 'racial identity' has been used when the groups being investigated (e.g., Black) or measures being used (e.g., the Multidimensional Inventory of Black Identity [MIBI]; Sellers et al., 1998) were considered racial, whereas 'ethnic identity' was used when the groups (e.g., Latinx) or measures (e.g., Multigroup Ethnic Identity Measure [MEIM]; Phinney & Ong, 2007) were considered ethnic. However, studies have demonstrated that ethnic identity development is stimulated by processes that are typically considered racial in nature (Cross, 1995) and racial identity attitudes have been associated with one's embracement of ethnic and cultural traditions (Cokley, 2005). Moreover, most racial identity and ethnic identity measures were not designed to be exclusively racial or

ethnic, respectively. The intricate relations between racial and ethnic identity are conceptually interwoven in such a way that may be difficult—if not impossible—to disentangle; hence, scholars have proposed the meta-construct of ethnic-racial identity to encapsulate these distinct-yet-related constructs. Measures assessing the ethnic-racial identity of ethnically-racially diverse adolescent samples have evidenced strong psychometric support for this meta-construct (Hughes et al., 2017; Wang et al., 2017).

Rooted in ethnic-racial identity theories (Cross, 1995), developmental process models have been used to understand the sequential phases through which youth develop a sense of belonging within and commitment to an ethnic-racial group. Importantly, developmental process models differ from content-oriented identity frameworks (Sellers et al., 1998). Content-oriented identity frameworks capture adolescents' evaluations of their ethnicity-race and the degree to which they integrate ethnicity-race into their self-concepts (i.e., centrality). However, these content-oriented identity theories have presented conflicting findings as to the role of ethnic-racial identity when encountering negative racial stereotypes. For instance, Social Identity Threat Theory (Steele et al., 2002) posits that youth who hold their ethnicity-race close to their self-concepts may feel the most hurt when negative racial stereotypes are salient. Conversely, the Rejection-Identification Model (Branscombe & Doosje, 2004) postulates that youth who are aware of racial stereotypes may hold their ethnicity-race closer to their self-concepts during times of adversity due to the sense of community it confers. Relative to these conflicting content-oriented theories, the identity development process model consistently positions youth's developing sense of belonging and commitment to their ethnic-racial group as protective factors against the negative effects of racial stereotypes (Yip et al., 2019).

In the identity development literature, two key concepts are common: exploration and commitment. Both exploration and commitment are particularly relevant to consider among middle and high schoolers as these processes are a salient part of adolescent development (Meeus, 2017). Exploration involves an individual's active search for information about what it means to be a member of their ethnic-racial group whereas commitment refers to one's sense of attachment to their in-group (Phinney & Ong, 2007). Although identity exploration and commitment are correlated dimensions of identity development, they may differentially moderate the effects of stereotype endorsement on academic outcomes. Scholars have posited that the development of a firm ethnic-racial identity commitment imbues adolescents with a positive sense of belonging to their ethnic-racial group and more psychosocial assets to cope with racial stressors (Phinney & Ong, 2007; Yip et al., 2019). If adolescents do not ultimately commit to their ethnic-racial identities, their ongoing process of exploring and grappling with race/ethnicity may not be sufficient to reduce the negative effects of prejudice and discrimination (Yip et al., 2019). Indeed, identity commitment has been consistently linked to positive academic and psychological outcomes (Rivas-Drake et al., 2014), whereas the effect of identity exploration on youth outcomes has produced less consistent findings (Syed et al., 2013; Yip et al., 2019). Therefore, identity exploration and commitment contain unique properties that may lead them to differentially buffer the effects of racial stereotype endorsement on Black adolescents' academic outcomes.

The Present Study

This study used a longitudinal design to explore the underlying socio-cognitive mechanisms connecting youth's racial stereotype endorsement to their math outcomes in a large sample of Black adolescents. We had two specific goals: (a) to test whether the link between

stereotype endorsement and math performance was mediated by cognitive engagement and ability mindset and (b) to examine whether the link between stereotype endorsement and math outcomes differed by gender or ethnic-racial identity.

We hypothesized that Black adolescents who endorsed negatively biased stereotypes would report lower cognitive engagement and stronger fixed mindsets than adolescents who endorsed neutral beliefs. This hypothesis is rooted in the literature showing that stereotype endorsement may reflect heightened awareness of or attention to stereotype knowledge (Pennington et al., 2016; Schmader et al., 2008). Subsequently, we postulated that lower cognitive engagement and stronger fixed mindsets would predict poorer math performance, suggesting a potential indirect effect of stereotype endorsement on math performance via these socio-cognitive factors. Although some have demonstrated the academic benefit of holding positively biased stereotypes (Walton & Cohen, 2003), others have suggested that adolescents are more likely to underperform and disengage from learning when they attribute academic performance to the presence of innate ability (Wang et al., 2019). Hence, we made no specific hypothesis regarding the impact of positively biased stereotypes. Considering that boys, on average, perform less well in academic domains (Kurtz-Costes et al., 2014; Voyer & Voyer, 2014) and are more likely to represent prototypes of race-based stereotypes in academics than girls (Purdie-Vaughns & Eibach, 2008), we hypothesized that Black boys would be most affected by their own endorsement of racial stereotypes. Finally, researchers have indicated that adolescents with greater ethnic-racial commitment might have more social resources and stronger social ties with other ethnic-racial group members that confer protection following the endorsement of stereotypes (Yip, 2018). Given such findings, we postulated that the link

between stereotype endorsement and math outcomes would be weaker for adolescents who reported greater commitment to their ethnic-racial group.

Method

Participants

Participants were 790 Black sixth (37.7%), eighth (35.1%), and 10th (25.7%) graders (50.7% girls and 49.3% boys; 88.6% qualified for a free or reduced-price lunch) from 16 urban public schools located in the Mid-Atlantic region of the United States. All school populations were primarily composed of White and Black students; however, schools varied in racial group representation as the percentage of Black students ranged from 11% to 80%. Across all schools, the teacher population was predominantly White (92%).

In this study, four waves of data across 2 years (i.e., fall and spring semesters) were examined. Year 1 data were collected when participants were in sixth, eighth, and 10th grades, and Year 2 data were collected when participants were in seventh, ninth, and 11th grades. All participants were retained in Wave 2, 84% were retained in Wave 3, and 82% were retained in Wave 4. To examine patterns of missing data, we first investigated the percentage of data that each participant had across all study variables. Seventy-five percent of students either had complete data or were missing data on only one study variable. Participants with missing data were more likely to have lower prior math achievement and math cognitive engagement than participants with complete data. These individuals did not differ on any other study variables. Little's (1988) missing completely at random test suggested that the data were missing completely at random, χ^2 (748) = 752.14, p = ns. We handled missing data using full-information maximum likelihood estimation (FIML), which allowed us to include all available data and

identify the parameter values with the highest probability of producing the sample data (Baraldi & Enders, 2010).

Procedure

In spring 2017, 20 schools from three regional districts of a Northeastern US state were invited to form a researcher-practitioner partnership involving a longitudinal study on school engagement and youth development. Administrators from these schools expressed concerns over equitable learning environments, and 16 out of 20 schools agreed to participate in data collection to further explore this topic. In the fall of the 2017-2018 academic year, all sixth-, eighth-, and 10th-grade students in the 16 schools were invited to participate in the study. More than 98% of eligible students agreed to partake in the study and this participation rate did not vary by schools, race, gender, or SES. This study only examined the Black student sample because of its specific focus on Black adolescents' racial stereotype endorsement and achievement. With assistance from the students' teachers, the research team distributed letters that described the study and assent/consent forms for students and their parents. Research staff then administered computer-based surveys to students during instructional time in the fall and spring. To address student variability in reading skill, all survey questions were audio-recorded and students were provided with headphones to listen to the questions. Research staff was available during survey administration to answer students' questions about the survey's purpose or content.

Measures

Math Achievement

Students' state standardized math test scores were collected from school records and used as indicators of math achievement at the end of the school year. The test scores were recalibrated

to a scale of 0–100 points, with a mean of 50 and a standard deviation of 10. Hence, the scores across years are directly comparable.

Endorsement of Racial Stereotypes

In the fall of Year 1 and Year 2, we measured adolescents' stereotype endorsement about racial differences in math competence by using the adapted version of the Racial Stereotype Related to Mathematics Scale (Munter & Haines, 2019). This adapted 2-item scale was validated using a sequential mixed-methods design and its reliability and validity have been established (Wang et al., 2022). Adolescents were asked to disclose their thoughts as to whether certain races are "typically good at math" and "have better performance in math." Separate sets of items were presented for Black students, such that students rated the ability of each racial group in mathematics with a 5-point response scale (1 = *strongly disagree*, 5 = *strongly agree*).[1] The order of racial groups was randomized to control for response bias.

A difference score was created to represent students' racial stereotype endorsement by subtracting out-group scores from in-group scores (e.g., subtract the item responses about White people from responses about Black people; possible range = -4 to 4). Values above zero indicated positively biased stereotypes (i.e., beliefs that Black people are better than White people in math), values below zero represented negatively biased stereotypes (i.e., beliefs that Black people are worse than White people in math), and zero values designated neutral (or lack of biased) stereotype endorsement. Subsequently, we created two categorical variables: one for negatively biased stereotype endorsement and the other for positively biased stereotype endorsement, with neutral belief as the reference category.

Math Cognitive Engagement

[1] To ensure students had sufficient knowledge about other racial groups to gauge their math abilities relative to their own, we focused on Black and White students, which reflected the schools' racial composition.

In the spring of Year 1 and Year 2, the Math Engagement Scale (Wang et al., 2016) was used to assess students' cognitive engagement in mathematics learning (six items; α = .75 and .75). Students rated their levels of intellectual investment, use of meta-cognitive strategies, and self-regulated learning in math over the past 6 months (e.g., "I go through the work that I do for math class and make sure that it's right"; "I try to connect what I am learning in math to things I have learned before"). Item responses were provided using a 5-point scale ranging from 1 (*Not at all like me*) to 5 (*Very much like me*). This student math engagement measure has demonstrated strong psychometric properties, including reliability, construct validity, and predictive validity (Wang et al., 2016). In addition, the measurement invariance test indicated that the engagement measure met criteria for scalar measurement invariance across gender, $\chi^2(30) = 253.86$, $p < .001$, RMSEA = .05, CFI = .97, TLI = .96, SRMR = .03. Higher scores reflected greater cognitive engagement.

Fixed Mindset Beliefs About Math Ability

In the spring of Year 1 and Year 2, items drawn from Dweck and colleagues' (Blackwell et al., 2007; Dweck, 2012) well-validated Math Ability Mindset scale were used to assess students' beliefs about the malleability of ability in math (four items; α = .84 and .87; e.g., "You have a certain amount of math ability/intelligence, and you can't really do much to change it"; "To be honest, you can't really change how smart you are in math"). Using a 5-point scale, students indicated the degree to which they endorsed these statements, with responses ranging from 1 (*Strongly Disagree*) to 5 (*Strongly Agree*). Higher scores reflected a stronger fixed math ability mindset. A measurement invariance test demonstrated that the mindset scale met criteria for scalar invariance across gender, $\chi^2(60) = 233.46$, $p < .001$, RMSEA = .03, CFI = .99, TLI = .98, SRMR = .03.

Ethnic-Racial Identity

In the spring of Year 1 and Year 2, adolescents' attitudes toward their race/ethnicity and beliefs about the formation of ethnic-racial identity were assessed by using the Multigroup Ethnic-Racial Identity Measure (Phinney & Ong, 2007; Spencer et al., 2000; Worrell & Gardner-Kitt, 2006). Two subscales were adopted from the MEIM: a three-item identity commitment scale (α = .79 and .82; e.g., "I have a strong sense of belonging to my own ethnic group"; "I feel a strong attachment towards my own racial/ethnic group") and a three-item identity exploration scale (α = .84 and .85; e.g., "I often do things that will help me understand my racial/ethnic background better"; "I often talk to other people in order to learn more about my racial/ethnic group"). Item responses were provide using a 5-point scale ranging from 1 (*Strongly Disagree*) to 5 (*Strongly Agree*). Higher scores reflected stronger levels of identity commitment and exploration.

Covariates

In addition to adolescents' self-reported gender information, we accounted for potential confounding variables in all models using school record data, including grade level, prior math achievement (i.e., standardized test scores from the 2015–2016 school year), prior cognitive engagement and ability mindset (data were collected from the prior year using the same measures described above), school membership (i.e., dummy variables for schools), school racial composition (percentage of Black students), and eligibility for free or reduced-price lunch (as a proxy of socioeconomic status; 0 = paid lunch, 1 = free or reduced lunch). Schools used federal income eligibility guidelines accounting for household size and income to determine students' qualification for free or reduced-price school meals.

Analytic Plan

We first tested whether the effects of racial stereotype endorsement on math achievement in each year were mediated by math cognitive engagement and math ability mindset by using bootstrapping approaches with the number of 2000 samples (MacKinnon et al., 2002). Students' gender, identity exploration, and identity commitment were included in the model as predictors alongside the covariates. We then added the interaction effects by including product terms between each moderator (i.e., gender, identity exploration, and identity commitment) and stereotype variables. For model parsimony, we removed non-significant interaction effects from the models sequentially. For significant gender × stereotype interaction effects, we recoded the gender variable so that the corresponding stereotype effects for boys and girls were both estimated and tested. For significant interaction effects involving the two ethnic-racial identity moderators, we used the Johnson-Neyman method to probe the interaction effect by plotting the stereotype variable (and 95% CIs) against a range (from -2 *SD* to 2 *SD*) of values on the corresponding moderator.

All analyses were conducted using structural equation modeling in *Mplus* 8.3 (Muthén, & Muthén, 1998–2015), which accounted for the nested data structure. The data structure had three levels: students nested within classrooms (134 classrooms) and schools (16 schools). The intraclass coefficients indicated that most of the math achievement outcome variance (between 79% and 81%) was at the student level relative to classroom and school levels. Because most of the math outcome variance occurred at the student level and the study's focus was on the student-level effects of racial stereotypes on math outcomes, we used the TYPE = COMPLEX command in *Mplus* and robust maximum likelihood estimation method (MLR) to produce robust standard errors adjusted for the clustering effect using a sandwich estimator. The standard errors for the estimates were then corrected based on residuals to accurately reflect the variability in the

estimates given the presence of clustering. Technical details about robust standard errors can be found in Asparouhov and Muthén (2006). The TYPE = COMPLEX approach has been found to be adequate and perform better in producing unbiased results than multilevel modeling approaches when the focus is not to disentangle effects at different levels (McNeish et al., 2017). To account for school effects, we used a fixed effect approach by including 15 dummy variables for the schools as covariates in the models given the small number of schools (Hox et al., 2010). MLR is a full information maximum likelihood method that incorporates missing data patterns in the model estimation process without deleting any incomplete cases (Yuan & Bentler, 2000). In a sensitivity analysis, we used multilevel modeling approach to account for the nested data structure and compared the results with the TYPE = COMPLEX approach.

Results

The correlations among key variables are shown in Table 1. All tested models fit the data well (see Table 2 and Table 3).

Mediation Effects of Cognitive Engagement and Ability Mindset

Math Cognitive Engagement as the Mediator

The model fit indices and results with math cognitive engagement as the mediator are presented in Table 2. As shown in Figure 2, negatively biased racial stereotype endorsement was associated with lower cognitive engagement in both years (a1 = -.24, p = .02 in Year 1; a1 = -.23, p = .05 in Year 2), whereas positively biased racial stereotype endorsement (vs. neutral belief) was associated with lower math cognitive engagement in Year 2, with only a marginally significant effect (a2 = -.24, p = .07). In both years, greater math cognitive engagement was associated with higher math scores (b = 2.91, p < .01 in Year 1; b = 2.15, p < .01 in Year 2). Thus, there was a significant indirect effect of negatively biased racial stereotype endorsement

on math scores through cognitive engagement in both years (ab1= -.70, 95% CI [-1.44, -0.12] for Year 1; ab1 = -.49, 95% CI [-1.07, -0.04] for Year 2). Specifically, negatively biased racial stereotype endorsement was associated with lower cognitive engagement, which in turn was associated with lower math scores.

Math Ability Mindset as the Mediator

The model fit indices and results with math ability mindset as the mediator are summarized in Table 3. Figure 2 illustrates that both negatively and positively biased racial stereotype endorsement were positively associated with fixed math mindset in both years (a1=.33, p = .02 and a2 = .42, p < .01 in Year 1; a1=.38, p = .05 and a2 = .61, p < .01 in Year 2). Black adolescents who endorsed stereotypes, regardless of the valence, tended to have stronger fixed math mindset beliefs than those with neutral racial beliefs (i.e., did not endorse positively or negatively biased stereotypes). Stronger fixed math mindsets were also associated with lower math scores. This association was statistically significant in both years (b = -1.49, p < .01 for Year 1; b = -1.75, p = .01 for Year 2). Consequently, we found significant indirect effects of racial stereotype endorsement on math scores through fixed ability mindset for both positively and negatively biased stereotypes in both years (Year 1: ab1 = -.49, 95% CI [-1.12, -0.06], ab2 = -.71, 95% CI [-1.34, -0.22]; Year 2: ab1 = -.67, 95% CI [-1.73, -0.02], ab2 = -1.07, 95% CI [-2.25, -0.18]). That is, racial stereotype endorsement, regardless of the valence of the beliefs, were associated with a stronger fixed math mindset, which in turn was associated with decreased test scores.

Moderation Effects of Gender and Ethnic-Racial Identity

Math Cognitive Engagement as the Mediator

Gender and identity exploration did not moderate the indirect effect of math cognitive engagement in either year. However, the association of positively and negatively biased racial stereotype endorsement with math cognitive engagement was moderated by identity commitment in Year 2 ($b = .30$, $p = .02$ for negatively biased stereotype endorsement and $b = .28$, $p = .05$ for positively biased stereotype endorsement; see Figure 3). Specifically, the negative association between racial stereotype endorsement and math cognitive engagement became smaller as identity commitment increased.

Math Ability Mindset as the Mediator

Neither identity commitment nor identity exploration moderated the indirect effect of math ability mindset. However, gender was found to moderate some of the racial stereotype endorsement effects. Specifically, in Year 1, gender moderated the association between racial stereotype endorsement and fixed ability mindset ($b = .47$, $p = .07$ for negatively biased stereotype endorsement; $b = .60$, $p < .01$ for positively biased stereotype endorsement). In Figure 3, probing the interaction effects suggested that both positively and negatively biased racial stereotypes had a significant effect on fixed mindset beliefs for boys ($a1 = .52$, $p < .01$ for negatively biased stereotype endorsement; $a2 = .72$, $p < .01$ for positively biased stereotype endorsement), but not for girls ($a1 = .09$, $p = .66$ for negatively biased stereotype endorsement; $a2 = .12$, $p = .45$ for positively biased stereotype endorsement). Consequently, the mediation effects of math ability mindset beliefs applied to boys only.

Sensitivity Analysis

We examined cross-year lagged effects by testing whether racial stereotype in Year 1 predicted cognitive engagement or mindset beliefs in Year 2 and subsequent math scores. We did not find cross-year lagged effects; in other words, the mediation effects mainly existed within

years rather than across years. We also used a multilevel modeling approach to account for the nested nature of the data in our sensitivity analysis. Specifically, we treated individuals as level 1 and classrooms as level 2 while using the fixed effect approach by including dummy variables for the schools as level-2 predictors. The parameter estimates using this multilevel modeling approach were comparable to the results using the TYPE = COMPLEX approach and the main findings (including mediation and moderation effects) remained the same between the two modeling approaches. The results using multilevel modeling approaches are reported in the Supplementary Materials (see Tables S1 and S2). Lastly, given that stereotype endorsement was measured in the fall whereas students' cognitive engagement, mindset beliefs, and math achievement were measured in the spring, we tested whether math achievement might mediate the association between stereotype endorsement and students' cognitive engagement and mindset beliefs. Math achievement did not mediate the link between stereotype endorsement and students' cognitive engagement and mindset beliefs.

Discussion

Drawing from an urban sample of Black adolescents, this study investigated whether cognitive engagement and ability mindsets mediated the associations between racial stereotype endorsement and math performance and whether any observed associations differed by adolescents' gender and ethnic-racial identity development. Multiple studies have shown that the endorsement of negative academic stereotypes diminishes the scholastic performance and psychoeducational development of Black students (Steele, 1997; Woodcock et al., 2012). However, the present study is among the first to examine the longitudinal associations with math-specific outcomes for both negatively and positively biased racial stereotype endorsement (Rowley et al., 2007). Our research presents novel findings about the socio-cognitive

mechanisms underlying the relations between stereotype endorsement and Black students' math achievement while also assessing whether gender and ethnic-racial identity moderated these relations.

Results suggested that endorsement of negatively biased stereotypes was associated with diminished cognitive engagement and, thereby, lower math scores across 2 years. Additionally, adolescents' ethnic-racial identity commitment (but not identity exploration) moderated the negative links between stereotype endorsement and math cognitive engagement in Year 2. That is, racial stereotype endorsement (both positively and negatively biased) was related to lower cognitive engagement in Year 2 only among Black students who reported low ethnic-racial identity commitment. When considering the mediating role of math ability mindsets, the endorsement of both positively and negatively biased racial stereotypes operated on math performance via its links to stronger fixed ability mindset beliefs in both years. Although ethnic-racial identity factors did not moderate the indirect effects of math ability mindsets, gender moderated the effects of racial stereotype endorsement on math mindset beliefs in Year 1. Specifically, the negative association between stereotype endorsement (both positively and negatively biased) and fixed mindset beliefs was significant for Black boys only.

Mediating Effects of Math Cognitive Engagement

Consistent with the development-in-sociocultural-context model as well as the broader empirical literature (Wang et al., 2019), our findings indicated that decreased cognitive engagement was one pathway by which endorsement of negatively biased stereotypes undermined Black students' math performance. Reckoning with negative stereotypes about math ability may be particularly important for these middle- and high-school students as awareness of racial academic stereotypes grows throughout middle childhood until it becomes widely salient

during adolescence, especially among Black youth (Beasley & Fischer, 2012; McKown & Weinstein, 2003).

For Black adolescents, internalizing negative in-group ability stereotypes may lead to a developmental process that reduces cognitive investment and academic learning in mathematics. Research has shown that stereotype threat inducement hinders perceptual and conceptual learning, cognitive flexibility, and intellectual interest and it also promotes disengaging behaviors (e.g., task avoidance) among stigmatized groups (Appel & Kronberger, 2012). Multiple lines of research have further indicated that membership in a societally stigmatized group is associated with a greater tendency to devalue, disidentify with, and disengage from domains in which their specific group is viewed as less capable (Del Toro & Wang, 2023; Nussbaum & Steele, 2007). Hence, negatively biased ability stereotypes in math may foment heightened levels of cognitive disengagement (Woodcock et al., 2012).

By contrast, we found little evidence that positively biased stereotypes were directly related to math cognitive engagement or indirectly associated with math performance. Theoretical scholarship has addressed why positive in-group stereotypes may buoy students' academic performance via stereotype boost or self-enhancement mechanisms (Rouland et al., 2013; Walton & Cohen, 2003). The lack of significant effects for positively biased stereotypes observed in this study may be due to racial and developmental differences in meaning making. Negative academic stereotypes about Black youth are widely pervasive in society and more prevalent among adolescents; therefore, positively biased stereotypes may have comparatively less psychological force among Black adolescents or evince effects only under specific conditions (Wang et al., 2019).

In fact, scholars have suggested that among Black students, positively biased stereotypes may be best construed as counter-stereotypes (Rowley et al., 2013). The argument asserts that counter-stereotypes may emerge as a coping strategy to shield Black children's academic self-beliefs against the negative effects of stigmatizing stereotypes. Therefore, these positively biased stereotypes (or counter-stereotypes) are more internally focused on self-enhancement rather than motivated by implicit bias against a specific target group (Rowley et al., 2013). For Black students, the increased cognitive load required to balance two competing (and contradictory) cognitions—their awareness of negatively biased academic stereotypes about Black people as a whole with their endorsement of positively biased stereotypes about themselves as individuals—may consequently cancel out the effects of each cognition. More research is necessary to explore which individual and contextual factors predict the adoption of positively biased stereotype beliefs among Black students and to understand under which circumstances positively biased stereotype endorsement may buttress or diminish academic outcomes.

Although the mediating pathway linking negatively biased racial stereotypes to lower math scores via diminished cognitive engagement held for both years in our analyses, it is notable that this indirect effect applied only to Black students with low levels of identity commitment in Year 2. These results suggest that stronger ethnic-racial identity commitment may act as a protective factor against the deleterious effects of academic stereotypes on cognitive engagement among Black students. Scholars have posited that the protective effects of stronger ethnic-racial identity commitment may operate through multiple channels. For instance, ethnic-racial identity commitment may imbue Black adolescents with more adaptive coping skills to deal with stigmatizing stereotypes and other forms of race-related adversity (Wang & Huguley, 2012). Greater ethnic-racial commitment also helps Black youth guard against the internalization

of negative stereotypes because these youth are more likely to ascribe such stereotypes to their collective, rather than personal, identities (Major et al., 1998). That is, Black youth may recognize that negative stereotypes reflect general societal prejudices about group tendencies that do not apply to them as individuals, and this belief might protect them from internalizing stigmatizing stereotype beliefs.

In addition, it is imperative to consider why the moderating effect of identity commitment was significant in Year 2 only. This association may reflect the developmental nature of identity formation. These processes unfurl rapidly during adolescence; ergo, there may have been considerable heterogeneity in youth's stage of identity formation between Year 1 and Year 2. Another explanation for this finding is that the strength of the moderating effect may have been camouflaged by a lack of methodological attention to identity content. Research has shown that identity status and content exert independent effects on youth outcomes (Yip, 2014). Black students who have strong attachments to their ethnic-racial group (i.e., identity status) and concomitantly hold more positive attitudes towards their ethnic-racial group (i.e., identity content) may be the youth best able to exhibit psychoeducational resilience to the negative effects of stigmatizing academic stereotypes.

Mediating Effects of Math Ability Mindset

The hypothesized role of math ability mindset as a route through which endorsement of both positively and negatively biased stereotypes shaped math performance across 2 years was supported in this study. These findings lend support to the contention that academic stereotypes are associated with Black students' beliefs about the relative contributions of natural ability and focused effort to math achievement. Growth-oriented mindsets are more adaptive because they promote greater persistence and behavioral investment in the face of academic struggles or

failures. However, implicit in an academic stereotype—whether positively or negatively biased—is the belief that academic achievement is the product of native, inherent attributes beyond the individual's control (Levy et al., 1998). Thus, when Black students internalize and endorse math-related stereotypes, these beliefs may lead to less adaptive attitudes towards the learning process because they draw a connection between their social (or collective) identities and immutable intellectual abilities (Nasir et al., 2017). Ultimately, stigmatized Black students may come to believe that effort is less important to their math performance than is innate intelligence.

It is also noteworthy that divergent findings across years were found when examining the moderating role of gender. Specifically, the association between stereotype endorsement and fixed math mindset existed for Black boys in Year 1 only. As outlined in the development-in-sociocultural-context model, the socio-cognitive processes underlying the connections between stereotype endorsement and academic outcomes tend to operate in complex ways at the nexus of race and gender. Accumulating research shows that Black boys are disproportionately more likely to be targets of negative stereotypes about their educational outcomes and school behavior than White youth, other Youth of Color, and Black girls (Wood et al., 2010). What is even more troubling is that negative bias towards Black boys has been observed as early as preschool (Gilliam et al., 2016). It should come as no surprise, then, that by middle and high school, Black boys are more likely than Black girls to internalize negative stereotypes about their academic ability (Evans et al., 2011). Together, these findings suggest that Black boys may be particularly vulnerable to the pernicious consequences of academic stereotypes. As previously discussed, developmental timing is likely a key factor in why these findings were found in one but not both years of the study. Indeed, our findings lend credence to extant literature showing that learning

environments and classroom processes not only differ dramatically from year to year, but they also interact dynamically with youth's developing competence beliefs and emergent identities (Oyserman et al., 2015; Wang, Degol, et al., 2020).

Future studies should continue to investigate how and why the sociocultural factors and psychosocial mechanisms that buttress or diminish math achievement may differ for Black boys and girls. In particular, it is imperative to consider Black girls' doubly marginalized and intersectional identities. During adolescence and in the school context, Black girls' gender identities may be especially salient, and gender stereotypes related to math could be more influential in shaping their math outcomes. At the same time, stereotypes about Black girls at the nexus of race and gender likely play a prominent role in the processes underlying the development of their math identities, engagement, and mindsets (Purdie-Vaughns & Eibach, 2008). It is important to investigate these factors given what scholarship has revealed about the pervasiveness of gender stereotypes about girls' math ability (Leslie et al., 2015).

Because the impact of racial stereotypes on learning outcomes appeared to be more salient within years rather than across years in our study, it is clear that learning contexts matter greatly. Classroom learning environments and interpersonal relationships with teachers and peers can change markedly from year to year during middle and high school (Wang, Degol, et al., 2020). During these formative years, classroom instructional practices, organizational structures, and social-cognitive processes differ substantively with the advent of whole group instruction, ability grouping, increasing academic rigor, and social comparison. Additionally, teachers vary greatly in how well they establish positive learning environments and cultivate supportive relationships with students. These factors and processes are particularly relevant for Black

adolescents as they experience more negative educational contexts and harbor academic perceptions that are highly sensitive to classroom characteristics (Bottiani et al., 2017).

Although the period spanning late childhood (ages 10–12 years) through adolescence (ages 13–17 years) is marked by major changes in children's competencies, social influences, and environmental demands, increasing theoretical and empirical evidence suggests that connections between children's self-beliefs and relevant behaviors operate similarly across this broad developmental phase (Davis-Kean et al., 2008; Marsh et al., 2018). Specifically, research has revealed that relations between children's academic and behavioral outcomes and their beliefs about their abilities and propensities remain consistent after middle childhood (Davis-Kean et al., 2008). Furthermore, recent scholarship has found that connections between math-specific self-beliefs and math performance evince developmental equilibrium across late childhood and adolescence (Marsh et al., 2018). This work suggests that although youth's self-beliefs may change (and their salience may intensify or weaken), the links between youth's competence beliefs and their behavior strengthen and remain stably robust after middle childhood. Insights from this work may help explain the consistent pattern of stronger within-year effects observed in this sample despite the multiple developmental time points examined in this study. Like self-beliefs, social identity-related beliefs, such as stereotypes, are constructed across the early and middle childhood years, partly derive from social comparisons (including status comparisons), and are sensitive to contextual cues (e.g., school-based discrimination, racial disparities in tracking; Barrett & Davis, 2008). Given these similarities, relations between stereotype beliefs and math performance may also exhibit greater developmental consistency.

Limitations

This study makes key contributions to the literature examining stereotype endorsement's relation with math outcomes; however, there are some limitations to note. Although we used reliable and well-validated instruments to assess youth's stereotype endorsement, explicit measures of stereotypes are more likely to be subject to social desirability bias and thus tend to produce discrepancies between responses on implicit and explicit measures (Peterson et al., 2016). To better understand the patterns of associations explored in this study, future scholarship should employ multiple methods to assess stereotype beliefs and determine how well they converge with each other and whether they differentially predict learning outcomes. Although research has suggested that stereotype awareness is associated with psychoeducational outcomes (Wang, Smith, et al., 2020), this work's focus on stereotype endorsement may obscure facets of how and why societal stereotypes influence the math identities and achievement of Black youth.

Moreover, our examination of the links between stereotype endorsement, math-related learning beliefs and behaviors, and math outcomes was limited to a sample of Black adolescents. Other racial groups are also subject to academic stereotypes—both positively biased and negatively biased—that may have implications for broader patterns of achievement, engagement, and learning among other populations of students. To gain an enhanced understanding of the role these sociocultural factors play in shaping youth development, future studies should examine how social identities and stereotype endorsement affect math outcomes among other racial/ethnic groups. In addition, given that students who had lower prior math achievement and cognitive engagement tended to have more missing data in this study, it would be informative to understand why these students were absent on the day of data collection and whether they might experience the impact of racial stereotype endorsement on their math achievement differently through qualitative research methods in future studies.

Although this study lays the groundwork for examining the content and valence of academic stereotypes and whether and how they impact youth learning, it will be essential for future research to apply an intersectional lens to these important questions. Specifically, Black adolescents' social identities are mutually constructed and interrelated, meaning that their classroom experiences play out in complex ways at the intersection of race and gender (Del Toro & Wang, 2021b; Wang et al., 2019). Given the experimental evidence showing that Black girls are discriminated against by educators and school counselors and viewed as less capable in math (irrespective of their objective math achievement), it is essential for researchers to develop instruments and design studies that investigate the intersectional bias (or gendered racism) that Black girls can confront at school (Francis et al., 2019).

Importantly, school contexts, including classroom practices and overt and subtle messages communicated by teachers and peers, can play a pivotal role in shaping children's learning-related beliefs and attitudes and reinforcing or undermining academic stereotypes (Wang et al., 2022). For example, Black students tend to report more demeaning and discriminatory experiences with teachers and other adult authority figures in their school contexts (Rosenbloom & Way, 2004; Wang et al., 2023). Black students also experience significant levels of peer discrimination in middle and high school, and greater perceived discrimination has been shown to undermine Black children's academic and psychological well-being (Hughes et al., 2016). Additionally, teachers also tend to hold lower academic expectations for Black students—including math—and some research suggests Black students are particularly sensitive to teachers' perceptions of their ability (Tyler & Boelter, 2008). Given such findings, future scholarship should also examine how classroom- and school-level contextual factors (e.g.,

classroom quality, teacher mindset beliefs, racial climate) may shape students' academic stereotype beliefs and math outcomes.

Conclusion

Black students confront an array of race-related challenges in their ecological environments and racial disparities in math learning are a concern for educators who seek to promote educational equity. In contrast with seminal work in this domain that has focused on how stereotype threat affects student performance (Nasir et al., 2017; Rowley et al., 2007), this study sought to understand one mechanism by which endorsement of academic stereotypes contributes to Black youth's learning attitudes, beliefs, behaviors, and performance. To apply insights from this work, teachers can design curriculum and learning environments that cultivate growth mindsets, particularly in math and science (Boaler, 2016; Maier et al., 2017). Educators can also focus on ways to promote positive racial climates in classrooms, ensure equity in the larger school community, create environments that provide students with social support, and buoy youth's coping skills (Aldana & Byrd, 2015; Del Toro & Wang, 2021a). In doing so, educators can help protect their students from the negative consequences of racialized and gendered stereotypes.

School psychologists also have a significant role to play in the quest to create more equitable school environments. Given their clinical training, school psychologists are well-positioned to translate research into practice for educators and administrators. Recent research has found that school-based racial socialization, including cultural socialization and promotion of cultural competence, can buttress Black adolescents' school climate perceptions, which in turn promote academic achievement (Wang et al., 2023). School psychologists can help develop and

advocate for these and other equity-focused, developmentally promotive programs aimed at counteracting the pernicious impacts of racial stereotypes on Black children and adolescents.

It is also important for teachers and school-based teams to adopt anti-racist practices that address institutional racism, interpersonal prejudice, and discrimination in their school settings. To create more supportive, culturally responsive learning environments for Black students, school administrators can work with school psychologists to develop and adopt schoolwide policies that address racial bias in disciplinary procedures and academic tracking, and educators can participate in professional development opportunities focused on culturally relevant pedagogy (Paris, 2012). Critically, to address systemic forms of school-based bias in the ways outlined above, school professionals (including teachers, administrators, leaders, and psychologists) must engage in a process of introspection and undergo their own critical consciousness development. That is, they must reflect on the sources of systemic oppression and engage in purposeful action to ameliorate school-based inequities (Sabnis & Proctor, 2022). This process involves identifying and combating their own internalized biases and stereotypes, which in turn puts them in a better position to recognize and dismantle inequitable school practices and policies. Ultimately, this study offers insights into how sociocultural processes operate in tandem to shape the math learning of Black youth, thereby representing a key step forward in the effort to understand this group's unique educational experiences and academic development.

References

Aldana, A., & Byrd, C. M. (2015). School ethnic-racial socialization: Learning About race and ethnicity among African American students. *The Urban Review, 47*(3), 563–576.

Appel, M., & Kronberger, N. (2012). Stereotypes and the Achievement Gap: Stereotype Threat Prior to Test Taking. *Educational Psychology Review, 24*(4), 609–635.

Asparouhov, T., & Muthén, B. (2006). *Multilevel modeling of complex survey data*. Proceedings of the Joint Statistical Meeting (pp. 2718–2726). Seattle, WA: ASA Section on Survey Research Methods.

Baraldi, A. N., & Enders, C. K. (2010). An introduction to modern missing data analyses. *Journal of School Psychology, 48*, 5–37. https://doi.org/10.1016/j.jsp.2009.10.001

Barrett, M., & Davis, S. C. (2008). Applying social identity and self-categorization theories to children's racial, ethnic, national and state identifications and attitudes. In S. M. Quintana & C. McKown (Eds.), *Handbook of race, racism, and the developing child* (pp. 72–110). John Wiley & Sons, Inc.

Beasley, M. A., & Fischer, M. J. (2012). Why they leave: The impact of stereotype threat on the attrition of women and minorities from science, math and engineering majors. *Social Psychology of Education, 15*, 427–448.

Blackwell, L. S., Trzesniewski, K. H., & Dweck, C. S. (2007). Implicit theories of intelligence predict achievement across an adolescent transition: A longitudinal study and an intervention. *Child Development, 78*, 246–263.

Boaler, J. (2016). *Mathematical mindsets*. Jossey-Bass.

Bottiani, J. H., Bradshaw, C. P., & Mendelson, T. (2017). A multilevel examination of racial disparities in high school discipline: Black and White adolescents' perceived equity,

school belonging, and adjustment problems. *Journal of Educational Psychology, 109*, 532–545.

Branscombe, N. R., & Doosje, B. (Eds.). (2004). Collective guilt: International perspectives. Cambridge University Press.

Brody, G. H., Kogan, S. M., & Chen, Y.-f. (2012). Perceived discrimination and longitudinal increases in adolescent substance use: Gender differences in mediational pathways. *American Journal of Public Health, 102*(5), 1006–1011. doi:10.2105/AJPH.2011.300588

Burnett, M., Kurtz-Costes, B., Vuletich, H. A., & Rowley, S. J. (2020). The development of academic and nonacademic race stereotypes in African American adolescents. *Developmental Psychology, 56*, 1750–1759. doi:10.1037/dev0001071

Chavous, T. M., Bernat, D. H., Schmeelk-Cone, K., Caldwell, C. H., Kohn-Wood, L., & Zimmerman, M. A. (2003). Racial identity and academic attainment among African American adolescents. *Child Development, 74*(4), 1076–1090.

Chouinard, R., & Roy, N. (2008). Changes in high-school students' competence beliefs, utility value and achievement goals in mathematics. *British Journal of Educational Psychology, 78*(Pt 1), 31–50.

Cokley, K. O. (2005). Racial(ized) identity, ethnic identity, and Afrocentric values: Conceptual and methodological challenges in understanding African American identity. *Journal of Counseling Psychology, 52*, 517–526. doi: 10.1037/0022-0167.52.4.517

Connell, J. P. (1990). Context, self, and action: A motivational analysis of self-system processes across the life span. In D. Cicchetti & M. Beeghly (Eds.), *The self in transition: Infancy to childhood* (pp. 61–97). University of Chicago Press.

Copur-Gencturk, Y., Cimpian, J. R., Lubienski, S. T., & Thacker, I. (2020). Teachers' bias against the mathematical ability of female, Black, and Hispanic students. *Educational Researcher, 49*, 30–43.

Crisp, R., Bache, L., & Maitner, A. (2009). Dynamics of social comparison in counter-stereotypic domains: Stereotype boost, not stereotype threat, for women engineering majors. *Social Influences, 4*, 171.

Cross, W. E., Jr. (1995). The psychology of nigrescence: Revising the Cross model. In J. G. Ponterotto, J. M. Casas, L. A. Suzuki, & C. M. Alexander (Eds.), *Handbook of multicultural counseling* (pp. 93–122). Sage.

Cunningham, M., Swanson, D. P., & Hayes, D. M. (2013). School- and community-based associations to hypermasculine attitudes in African American adolescent males. *American Journal of Orthopsychiatry, 83*, 244–251.

Davis-Kean, P. E., Huesmann, L. R., Jager, J., Collins, W. A., Bates, J. E., & Lansford, J. E. (2008). Changes in the relation of self-efficacy beliefs and behaviors across development. *Child Development, 79*, 1257–1269.

Del Toro, J., & Wang, M.-T. (2021a). School cultural socialization and academic performance: Examining ethnic-racial identity development as a mediator among youth of color. *Child Development, 92*, 1458–1475.

Del Toro, J., & Wang, M.-T. (2021b). Longitudinal inter-relations among schools' cultural socialization, school climate, and school engagement among urban Black early adolescents. *Learning and Instruction, 75*, 1-9.

Del Toro, J., & Wang, M.-T. (2023). Stereotypes in the classroom's air: Classroom racial stereotype endorsement, classroom engagement, and STEM achievement among Black and White American adolescents. *Developmental Science.*

Devine, P. G. (1989). Stereotypes and prejudice: Their automatic and controlled components. *Journal of Personality and Social Psychology, 56*(1), 5–18.

Dweck, C. S. (2012). Mindsets and human nature: Promoting change in the Middle East, the schoolyard, the racial divide, and willpower. *American Psychologist, 67*(8), 614–622.

Evans, A. B., Copping, K. E., Rowley, S. J., & Kurtz-Costes, B. (2011). Academic self-concept in Black adolescents: Do race and gender stereotypes matter? *Self and Identity, 10*, 263–277.

Francis, D. V., de Oliveira, A. C., & Dimmitt, C. (2019). Do school counselors exhibit bias in recommending students for advanced coursework? *Journal of Economic Analysis & Policy, 19*, 20180189.

Gilliam, W. S., Maupin, A. N., Reyes, C. R., Accavitti, M., & Shic, F. (2016). *Do early educators' implicit biases regarding sex and race relate to behavior expectations and recommendations of preschool expulsions and suspensions*. Yale University Child Study Center.

Gocłowska, M. A., Crisp, R. J., & Labuschagne, K. (2013). Can counter-stereotypes boost flexible thinking? *Group Processes & Intergroup Relations, 16*(2), 217–231.

Griffin, C. B., Cooper, S. M., Metzger, I. W., Golden, A. R., & White, C. N. (2017). School racial climate and the academic achievement of African American high school students: The mediating role of school engagement. *Psychology in the Schools, 54*(7), 673–688.

Hentges, R. F., Galla, B. M., & Wang, M. T. (2019). Economic disadvantage and math achievement: The significance of perceived cost from an evolutionary perspective. *British Journal of Educational Psychology, 89*(2), 343–358. doi:10.1111/bjep.12242

Hughes, D., Del Toro, J., Harding, J. F., Way, N., & Rarick, J. R. (2016). Trajectories of discrimination across adolescence: Associations with academic, psychological, and behavioral outcomes. *Child Development, 87*, 1337–1351.

Hughes, D., Del Toro, J., & Way, N. (2017). Interrelations among dimensions of ethnic-racial identity during adolescence. *Developmental Psychology, 53*(11), 2139–2153.

Hughes, D., Rodriguez, J., Smith, E. P., Johnson, D. J., Stevenson, H. C., & Spicer, P. (2006). Parents' ethnic-racial socialization practices: A review of research and directions for future study. *Developmental Psychology, 42*(5), 747–770.

Kurtz-Costes, B., Swinton, A. D., & Skinner, O. D. (2014). Racial and ethnic gaps in the school performance of Latino, African American, and White students. In F. T. L. Leong, L. Comas-Díaz, C. Nagayama Hall, V. C. McLoyd, & J. E. Trimble (Eds.), *APA handbook of multicultural psychology, Vol. 1: Theory and research*. (pp. 231–246). American Psychological Association.

Leslie, S.-J., Cimpian, A., Meyer, M., & Freeland, E. (2015). Expectations of brilliance underlie gender distributions across academic disciplines. *Science, 347*(6219), 262–265.

Levy, S. R., Stroessner, S. J., & Dweck, C. S. (1998). Stereotype formation and endorsement: The role of implicit theories. *Journal of Personality and Social Psychology, 74*, 1421–1436.

Little, R. J. A. (1988). Robust estimation of the mean and covariance matrix from data with missing values. *Applied Statistics, 37*, 23–38.

MacKinnon, D. P., Lockwood, C. M., Hoffman, J. M., West, S. G., & Sheets, V. (2002). A comparison of methods to test mediation and other intervening variable effects. *Psychological Methods, 7,* 83-104.

Maier, A., Daniel, J., Oakes, J., & Lam, L. (2017). Community schools as an effective school improvement strategy: A review of the *evidence*. Palo Alto, CA: Learning Policy Institute.

Major, B., Spencer, S., Schmader, T., Wolfe, C., & Crocker, J. (1998). Coping with negative stereotypes about intellectual performance: The role of psychological disengagement. *Personality and Social Psychology Bulletin, 24*(1), 34–50.

Marsh, H. W., Pekrun, R., Murayama, K., Arens, A. K., Parker, P. D., Guo, J., & Dicke, T. (2018). An integrated model of academic self-concept development: Academic self-concept, grades, test scores, and tracking over 6 years. *Developmental Psychology, 54*, 263–280.

Martin, D. (2007). Beyond missionaries or cannibals: Who should teach mathematics to African American children? *High School Journal, 91*, 6–28.

Martin, D. (2009). Researching race in mathematics education. *Teachers College Record, 111*, 295–338.

McKown, C., & Weinstein, R. S. (2003). The development and consequences of stereotype consciousness in middle childhood. *Child Development, 74*(2), 498–515.

McNeish, D., Stapleton, L. M., & Silverman, R. D. (2017). On the unnecessary ubiquity of hierarchical linear modeling. *Psychological Methods, 22*, 114–140. https://doi.org/10.1037/met0000078

Meeus, W. (2017). Adolescent ethnic identity in social context: A commentary. *Child Development, 88*(3), 761–766. doi:10.1111/cdev.12785

Mrazek, A. J., Ihm, E. D., Molden, D. C., Mrazek, M. D., Zedelius, C. M., & Schooler, J. W. (2018). Expanding minds: Growth mindsets of self-regulation and the influences on effort and perseverance. *Journal of Experimental Social Psychology, 79*, 164–180.

Munter, C., & Haines, C. (2019). Mathematics teachers' enactment of cognitively demanding tasks and students' perception of racial differences in opportunity. *Mathematical Thinking and Learning, 21*, 155–177.

Muthén LK, Muthén BO. Mplus user's guide (7th ed.). Los Angeles, CA: Muthén & Muthén; 1998–2015. https://www.statmodel.com/ugexcerpts.shtml

Nasir, N. I. S., McKinney de Royston, M., O'Connor, K., & Wischnia, S. (2017). Knowing about racial stereotypes versus believing them. *Urban Education, 52*(4), 491–524.

Nasir, N. S., Hand, V., & Taylor, E. (2008). Culture and mathematics in school: Boundaries between "cultural" and "domain" knowledge in the mathematics classroom and beyond. *Review of Research in Education, 32*, 187–240.

National Science Foundation. (2018). *Women, minorities, and persons with disabilities in science and engineering: 2011*. National Science Foundation.

Nussbaum, A. D., & Steele, C. M. (2007). Situational disengagement and persistence in the face of adversity. *Journal of Experimental Social Psychology, 43*(1), 127–134.

Oyserman, D., Destin, M., & Novin, S. (2015). The context-sensitive future self: Possible selves motivate in context, not otherwise. *Self and Identity, 14*, 173–188.

Paris, D. (2012). Culturally sustaining pedagogy: A needed change in stance, terminology, and practice. *Educational Researcher, 41*, 93–97.

Pauker, K., Xu, Y., Williams, A., & Biddle, A. M. (2016). Race essentialism and social contextual differences in children's racial stereotyping. *Child Development, 87*, 1409-1422.

Paunesku, D., Walton, G. M., Romero, C., Smith, E. N., Yeager, D. S., & Dweck, C. S. (2015). Mind-set interventions are a scalable treatment for academic underachievement. *Psychological Science, 26*, 784–793.

Pennington, C. R., Heim, D., Levy, A. R., & Larkin, D. T. (2016). Twenty years of stereotype threat research: A review of psychological mediators. *PLoS ONE, 11*(1), e0146487.

Pennsylvania Department of Education (2010). *Psychometric analysis report for the fall 2010 Keystone field tests*. PDE.

Peterson, E. R., Rubie-Davies, C., Osborne, D., & Sibley, C. (2016). Teachers' explicit expectations and implicit prejudiced attitudes to educational achievement: Relations with student achievement and the ethnic achievement gap. *Learning and Instruction, 42*, 123–140.

Phinney, J. S., & Ong, A. D. (2007). Conceptualization and measurement of ethnic identity: Current status and future directions. *Journal of Counseling Psychology, 54*(3), 271–281.

Pickering, M. (2004). Racial stereotypes. In Gary Taylor & Steve Spencer (Eds.), *Social identities: Multidisciplinary approaches* (pp. 91–106). New York: Routledge

Plante, I., O'Keefe, P. A., Aronson, J., Fréchette-Simard, C., & Goulet, M. (2019). The interest gap: How gender stereotype endorsement about abilities predicts differences in academic interests. *Social Psychology of Education: An International Journal, 22*(1), 227–245.

Purdie-Vaughns, V., & Eibach, R. P. (2008). Intersectional invisibility: The distinctive advantages and disadvantages of multiple subordinate-group identities. *Sex Roles: A Journal of Research, 59*(5–6), 377–391. doi:10.1007/s11199-008-9424-4

Riegle-Crumb, C., Morton, K., Nguyen, U., & Dasgupta, N. (2019). Inquiry-based instruction in science and mathematics in middle-school classrooms: examining its association with students' attitudes by gender and race/ethnicity. *AERA Open, 5*, 1–17

Rivas-Drake, D., Syed, M., Umaña‐Taylor, A., Markstrom, C., French, S., Schwartz, S. J., & Lee, R. (2014). Feeling good, happy, and proud: A meta-analysis of positive ethnic-racial affect and adjustment. *Child Development, 85*, 77–102.

Rosenbloom, S. R., & Way, N. (2004). Experiences of discrimination among African American, Asian American, and Latino adolescents in an urban high school. *Youth & Society, 35*, 420–451.

Rouland, K. K., Rowley, S. J., & Kurtz-Costes, B. (2013). Self-views of African-American youth are related to the gender stereotypes and ability attributions of their parents. *Self and Identity, 12*, 382–399.

Rowley, S. J., Kurtz-Costes, B., Mistry, R., & Feagans, L. (2007). Social status as a predictor of race and gender stereotypes in late childhood and early adolescence. *Social Development, 16*(1), 150–168. doi:10.1111/j.1467-9507.2007.00376.x

Rowley, S. J., Kurtz-Costes, B., & Rouland, K. (2013). Self views of African American youth are related to the gender stereotypes and academic attributions of their mothers. *Self Identity, 12*, 382–399. https://doi.org/10.1080/15298868.2012.682360

Sabnis, S. V., & Proctor, S. L. (2022). Use of critical theory to develop a conceptual framework for critical school psychology. *School Psychology Review, 51*, 661–675.

Schmader, T., Johns, M., & Forbes, C. (2008). An integrated process model of stereotype threat effects on performance. *Psychological Review, 115*(2), 336–356.

Sellers, R. M., Smith, M. A., Shelton, J. N., Rowley, S. A. J., & Chavous, T. M. (1998). Multidimensional model of racial identity: A reconceptualization of African American racial identity. *Personality and Social Psychology Review, 2*, 18–39.

Spencer, M. S., Icard, L. D., Harachi, T. W., Catalano, R. F., & Oxford, M. (2000). Ethnic identity among monoracial and multiracial early adolescents. *The Journal of Early Adolescence, 20*(4), 365–387.

Steele, C. M. (1997). A threat in the air: How stereotypes shape intellectual identity and performance. *American Psychologist, 52*(6), 613–629.

Steele, C. M., & Aronson, J. (1995). Stereotype threat and the intellectual test performance of African Americans. *Journal of Personality and Social Psychology, 69*, 797–811.

Steele, C. M., Spencer, S. J., & Aronson, J. (2002). Contending with group image: The psychology of stereotype and social identity threat. In *Advances in experimental social psychology* (Vol. 34, pp. 379–440). Elsevier.

Syed, M., Walker, L. H. M., Lee, R. M., Umaña-Taylor, A. J., Zamboanga, B. L., Schwartz, S. J., Armenta, B. E., & Huynh, Q.-L. (2013). A two-factor model of ethnic identity exploration: Implications for identity coherence and well-being. *Cultural Diversity and Ethnic Minority Psychology, 19*, 143–154. https://doi.org/10.1037/a0030564

Taningco, M.T., A. B. Mathew, and H. P. Pachon. 2008. STEM Professions: Opportunities and Challenges for Latinos in Science, Technology, Engineering and Mathematics. Los Angeles, CA: Tomas Rivera Policy Institute.

Tyler, K. M., & Boelter, C. M. (2008). Linking Black middle school students' perceptions of teachers' expectations to academic engagement and efficacy. *Negro Educational Review, 59*, 27–44.

Voyer, D., & Voyer, S. D. (2014). Gender differences in scholastic achievement: A meta-analysis. *Psychological Bulletin, 140*, 1174–1204. doi:10.1037/a0036620

Walton, G. M., & Cohen, G. L. (2003). Stereotype lift. *Journal of Experimental Social Psychology, 39*, 456–467. doi:10.1016/S0022-1031(03)00019-2

Wang, M.-T., & Degol, J. S. (2013). Motivational pathways to STEM career choices: Using expectancy-value perspective to understand individual and gender differences in STEM fields. *Developmental Review, 33*, 304–340.

Wang, M.-T., Degol, J. S., Amemiya, J. L., Parr. A., & Guo, J. (2020). Classroom climate and children's academic and psychological wellbeing: A systematic review and meta-analysis. *Developmental Review, 57*, 1-27.

Wang, M.-T., Degol, J. L., & Henry, D. A. (2019). An integrative development-in-sociocultural-context model for children's engagement in learning. *American Psychologist*, *74*, 1086–1102.

Wang, M.-T., Fredricks, J. A., Ye, F., Hofkens, T. L., Schall, J. (2016). The math and science engagement scale: Scale development, validation, and psychometric properties. *Learning and Instruction, 43*, 16–26.

Wang, M.-T., & Huguley, J. P. (2012). Parental racial socialization as a moderator of the effects of racial discrimination on educational success among African American adolescents. *Child Development, 83*(5), 1716–1731. doi:10.1111/j.1467-8624.2012.01808.x

Wang, M.-T., Scanlon, C. L., Del Toro, J., & McKellar, S. (2022). Reducing suspension for minor infraction and improving school climate perceptions among Black adolescents via cultural socialization: A multi-informant longitudinal study. *Learning and Instruction, 80*, 101621.

Wang, M.-T., Ye, F., & Degol, J. L. (2017). Who chooses STEM careers? Using a relative cognitive strength and interest model to predict careers in science, technology, engineering, and mathematics. *Journal of Youth and Adolescence, 46*(8), 1805–1820.

Wang, M.-T., Henry, D. A., & Del Toro, J. (2023). Do Black and White students benefit from racial socialization? School racial socialization, school climate, and youth academic performance during early adolescence. *American Educational Research Journal, 60*, 405-444.

Wang, M.-T., Henry, D. A., Wu, W., Del Toro, J., & Huguley, J. P. (2022). Racial stereotype endorsement, cognitive engagement, growth mindset, and mathematics performance among Black and White American adolescents. *Journal of Youth and Adolescence, 51*, 984–1001.

Wang, M.-T., Smith, L. V., Huguley, J. P., & Miller-Cotto, D. A. (2020). Parental ethnic-racial socialization and children of color's academic success: A meta-analytic review. *Child Development, 91,* 528-544.

Wang, Y., Douglass, S., & Yip, T. (2017). Longitudinal relations between ethnic/racial identity process and content: Exploration, commitment, and salience among diverse adolescents. *Developmental Psychology, 53*(11), 2154–2169. https://doi.org/10.1037/dev0000388

Wilkerson , I. (2020). *Caste: The origins of our discontents*. Random House.

Wood, D., Kurtz-Costes, B., Rowley, S. J., & Okeke-Adeyanju, N. (2010). Mothers' academic gender stereotypes and education-related beliefs about sons and daughters in African American families. *Journal of Educational Psychology, 102*(2), 521.

Woodcock, A., Hernandez, P. R., Estrada, M., & Schultz, P. W. (2012). The consequences of chronic stereotype threat: Domain disidentification and abandonment. *Journal of Personality and Social Psychology, 103*(4), 635–646. doi:10.1037/a0029120

Worrell, F. C. & Gardner-Kitt, D. L. (2006). The relationship between racial and ethnicity in Black adolescents: The cross racial identity scale and the multigroup ethnic identity

Yip, T. (2014). Ethnic identity in everyday life: The influence of identity development status. *Child Development, 85*, 205–219.

Yip, T. (2018). Ethnic/racial identity: A double-edged sword? Associations with discrimination and psychological outcomes. *Current Directions in Psychological Science, 27*, 170–175.

Yip, T., Wang, Y., Mootoo, C., & Mirpuri, S. (2019). Moderating the association between discrimination and adjustment: A meta-analysis of racial/ethnic identity. *Developmental Psychology, 55*, 1274–1298.

Yuan, K. H., & Bentler, P. M. (2000). Three likelihood-based methods for mean and covariance structure analysis with nonnormal missing data. *Sociological Methodology, 30*, 165–200.

Table 1

Correlations Among the Key Variables

Variables	Final Math score (Y)	Negative stereotype vs. neutral beliefs in fall (X1)	Positive stereotype vs. neutral beliefs in fall (X2)	Math fixed mindset in spring (X3)	Cognitive engagement in spring (X4)	Boys (X5)	Identity exploration in spring (X6)	Identity commitment in spring (X7)	Grade level (X8)	Prior math achievement (X9)	School racial composition (X10)	Free or reduced lunch (X11)
Y	1	-0.10*	0.04	-.18**	.22**	-.09*	0.07	.14*	-.24**	.51**	0.02	-.15**
X1	-0.09*	1	-.33**	0.07	-.14**	-0.01	-0.08	-0.03	-0.01	-0.03	-0.03	-0.04
X2	-0.06*	-.16**	1	.12**	0.05	-0.02	0.06	0.05	-.11*	0.09	-.13**	-0.06
X3	-.18**	.11*	.20**	1	-.31**	.17**	-0.06	-0.05	-0.04	-0.01	.07*	0.03
X4	.22**	-.13*	-.10*	-.42**	1	-.08**	.22**	.22**	-.09.	0.01	0.02	0.04
X5	-.25**	-0.03	0.02	.15**	-.10*	1	-0.03	-0.02	-.09**	-0.07	0.01	-0.03
X6	0.03	-0.03	0.05	-0.06	.13*	-0.03	1	.76**	0.07	-0.06	-0.03	-.12*
X7	0.04	-0.04	-0.02	-0.08	.13*	-0.02	.76**	1	-0.1	0.05	0.01	0.06
X8	-.17*	0.05	.10*	0.09	0.03	-0.05	0.08	-.13*	1	-0.08	0.02	-0.03
X9	.38**	-0.02	0.04	0.01	.13*	-.08*	-.10*	.11*	-12**	1	-0.07	-0.08
X10	-0.04	-0.02	-0.09	0.02	-0.01	0.01	-0.03	0.01	0.04	-0.05	1	.31**
X11	-.10*	-.17*	-0.05	0.01	0.04	-0.04	-0.11	0.04	-0.01	-.12**	.32**	1

Note. The upper diagonal contains correlations for year 1; the lower diagonal contains correlations for Year 2.

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

Table 2

Math Cognitive Engagement as a Mediator

Effects	Year 1				Year 2			
	b	*SE*	*p*	*β*	*b*	*SE*	*p*	*β*
Direct Effects on Cognitive Engagement in the Spring								
Negative stereotype vs. neutral belief in the fall (a1)	-0.24*	0.10	0.02	-.12	-0.23*	0.12	0.07	-.10
Positive stereotype vs. neutral belief in the fall (a2)	-0.07	0.08	0.43	-.04	-0.24+	0.14	0.07	-.12
Boys	-0.08	0.05	0.13	-.05	0.01**	0.00	< .01	.23
Identity exploration in the spring	0.12*	0.06	0.04	.13	-0.10	0.06	0.11	-.07
Identity commitment in the spring	0.08	0.06	0.15	.09	0.08	0.07	0.28	.09
Prior math achievement	0.01**	0.00	< .01	.16	0.07	0.06	0.26	.07
School racial composition	-0.09	0.20	0.64	-.02	-0.28	0.22	0.21	-.05
Grade level	-0.08*	0.04	0.05	-.17	-0.14**	0.04	<.01	-.29
Free/reduced price lunch	0.02	0.09	0.87	.01	0.01	0.12	0.92	.05
Identity commitment × negative stereotype vs. neutral belief	—	—	—	—	0.30*	0.13	0.02	0.13
Identity commitment × positive stereotype vs. neutral belief	—	—	—	—	0.28*	0.14	0.05	0.12
Direct Effects on Final Math Achievement								
Cognitive engagement in the spring (b)	2.91**	0.57	< .01	.15	2.15**	0.70	< .01	.11
Negative stereotype vs. neutral belief in the fall (c1)	-0.57	1.53	0.71	-.02	-1.51	2.28	0.51	-.04
Positive stereotype vs. neutral belief in the fall (c2)	1.77	1.16	0.13	.06	0.08	2.17	0.97	<.01
Boys	-3.09**	0.96	< .01	-.11	-5.40**	0.93	< .01	-.19
Identity exploration	-0.87	0.69	0.21	-.05	-0.64	0.94	0.50	-.04
Identity commitment	1.18+	0.69	0.09	.07	1.25	0.95	0.19	.07
Prior math achievement	0.40**	0.05	< .01	.43	0.21**	0.04	< .01	.23
School racial composition	-2.65	3.44	0.44	-.03	-2.13	3.69	0.56	-.02
Grade level	0.68	0.59	0.26	.08	-0.34	0.71	0.63	-.04
Free/reduced price lunch	-3.78**	1.18	< .01	-.08	-1.26	1.52	0.41	-.03
Indirect effects	*b*		CI		*b*		CI	
Negative stereotype vs. neutral belief in the fall → *cognitive engagement in the spring* → final test score (ab1)	-0.70*	95% CI [-1.44, -0.12]			-0.49*	95% CI [-1.07, -0.04]		
Positive stereotype vs. neutral belief in the fall → *cognitive engagement in the spring* → final test score (ab2)	-0.19	95% CI [-0.70, 0.29]			-0.53+	95% CI [-1.16, -0.03]		
Model Fit	$\chi^2(63) = 465.39$, $p < .001$, RMSEA = .03, CFI = .99, TLI = .99, SRMR = .01				$\chi^2(43) = 362.29$, $p < .001$, RMSEA = .03, CFI = .99, TLI = .99, SRMR = .01			

Note. *b* and *β* represent unstandardized and standardized coefficients, respectively.

$^{+}p < .10$. $*p < .05$. $**p < .01$.

Table 3

Math Fixed Ability Mindset as The Mediator

Effects	Year 1				Year 2			
	b	*SE*	*p*	*β*	*b*	*SE*	*p*	*β*
Direct Effects on Fixed Ability Mindset in the Spring								
Negative stereotype vs. neutral belief in the fall (a1)	0.33*	0.14	0.02	0.13	0.38*	0.19	0.05	0.14
Positive stereotype vs. neutral belief in the fall (a2)	0.42**	0.10	< 0.01	0.20	0.61**	0.16	< .01	0.23
Boys	0.32**	0.07	< 0.01	0.26	-0.01	0.00	0.08	-0.12
Identity exploration in the spring	-0.07	0.07	0.28	-0.06	0.25	0.08	< .01	0.13
Identity commitment in the spring	0.03	0.07	0.64	0.03	-0.06	0.09	0.47	-0.06
Prior math achievement	-0.01*	<0.01	0.02	-0.12	-0.06	0.09	0.48	-0.05
School racial composition	-0.26	0.24	0.27	-0.04	-0.08	0.17	0.65	-0.01
Grade Level	-0.01	0.04	0.89	-0.01	0.08	0.04	0.05	0.14
Free/reduced price lunch	0.16	0.13	0.20	0.05	0.07	0.13	0.62	0.02
Gender × negative stereotype vs. neutral belief	0.47+	0.27	0.08	0.14	—	—	—	—
Gender × negative stereotype vs. neutral belief	0.60**	0.21	< 0.01	0.22	—	—	—	—
Direct Effects on Final Math Achievement								
Fixed ability mindset in the spring (b)	-1.49**	0.50	< 0.01	-.010	-1.75**	0.72	0.01	-0.12
Negative stereotype vs. neutral belief in the fall (c1)	-0.83	1.52	0.58	-0.02	-1.97	2.27	0.39	-0.05
Positive stereotype vs. neutral belief in the fall (c2)	2.27*	1.15	0.05	0.07	0.26	2.15	0.91	0.01
Boys	-2.83**	0.99	< 0.01	-0.10	-5.19**	0.95	< .01	-0.18
Identity exploration in the spring	-.66	0.68	0.34	-0.04	-0.47	0.91	0.61	-0.03
Identity commitment in the spring	1.41*	0.69	0.04	0.08	1.21	0.96	0.21	0.07
Prior math achievement	0.41**	0.05	< 0.01	0.44	0.22**	0.04	< .01	0.24
School racial composition	3.38	3.33	0.31	-0.03	-1.70	3.68	0.64	0.02
Grade level	0.44	0.57	0.45	0.05	-0.49	0.70	0.48	-0.06
Free/reduced price lunch	-3.53**	1.15	< 0.01	-0.08	-0.96	1.55	0.54	-0.02
Indirect effects	*b*		CI		*b*		CI	
Negative stereotype vs. neutral belief in the fall → fixed ability mindset in the spring → final test score (ab1)	-0.49*		95% CI [-1.12, -0.06]		-0.67*		95% CI [-1.73, -0.02]	
Positive stereotype vs. neutral belief in the fall → fixed ability mindset in the spring → final test score (ab2)	-0.62*		95% CI [-1.21, -0.17]		-1.07*		95% CI [-2.25, -0.18]	
Model Fit	$\chi^2(82) = 776.09$, $p < .001$, RMSEA = .01, CFI = .99, TLI = .99, SRMR = .01				$\chi^2(82) = 544.02$, $p < .001$, RMSEA = .01, CFI = .99, TLI = .99, SRMR = .01			

Note. *b* and *β* represent unstandardized and standardized coefficients, respectively.

$^{+}$p < .10. *p < .05. ** p < .01.

Figure 1

A Conceptual Model of Key Constructs in the Present Study

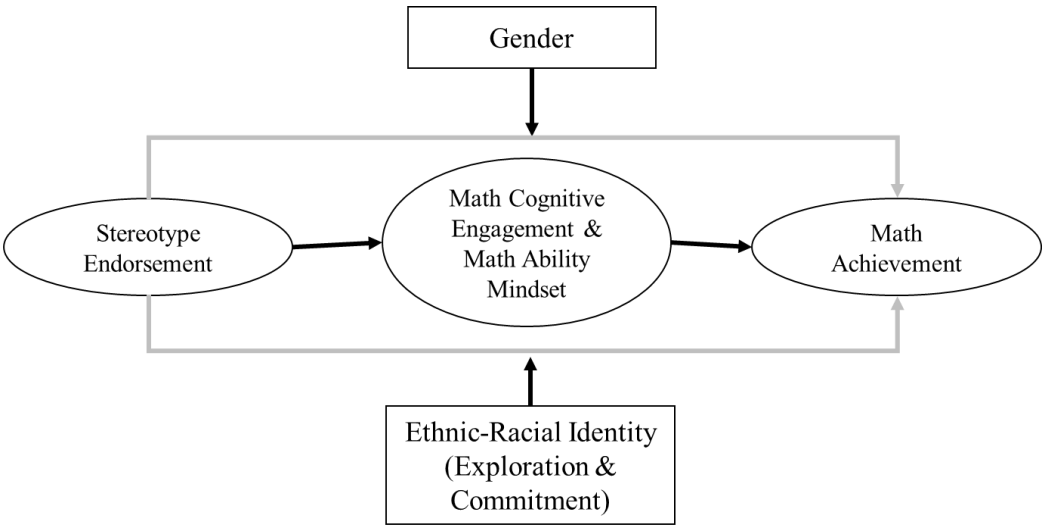
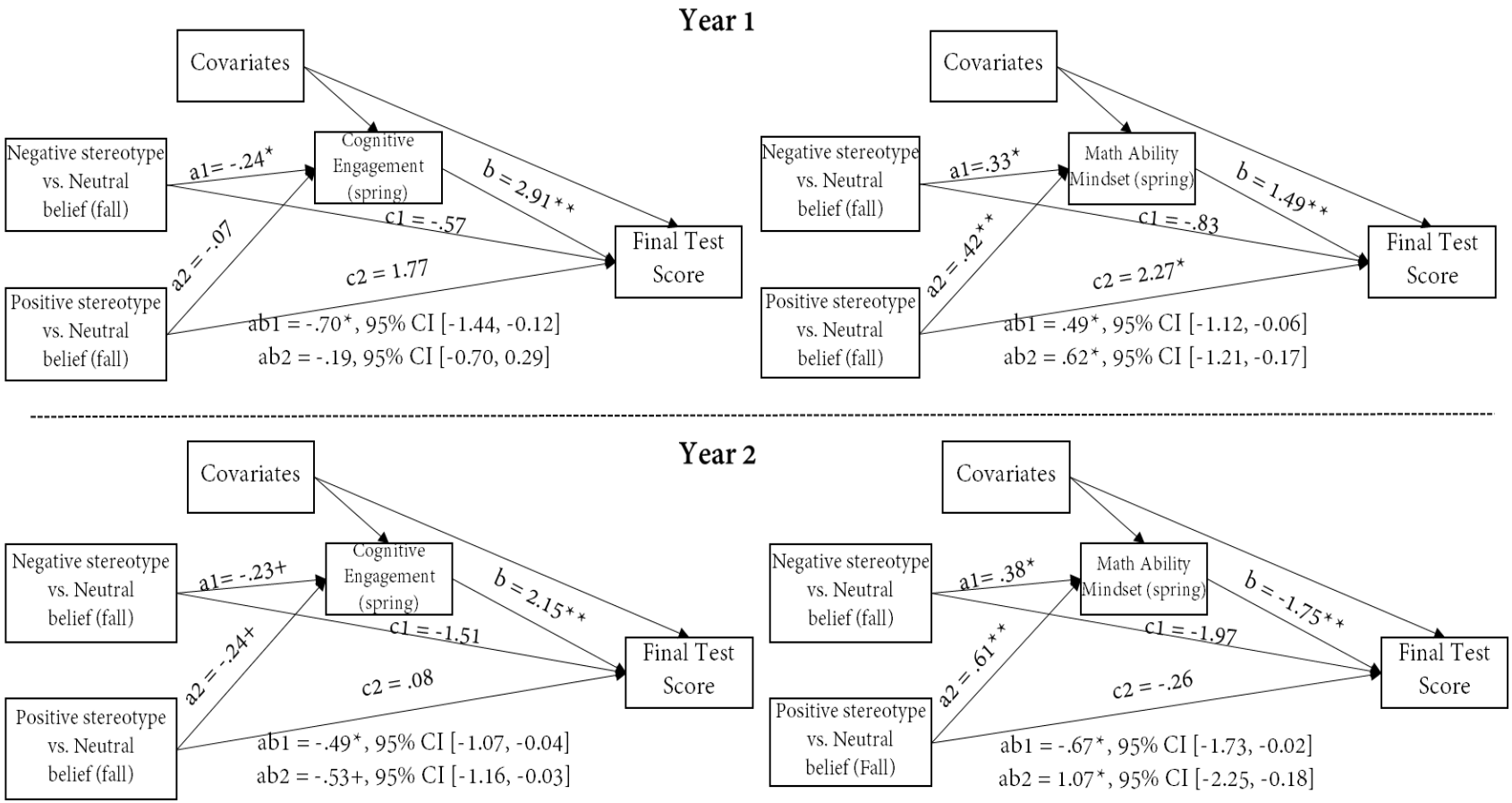


Figure 2

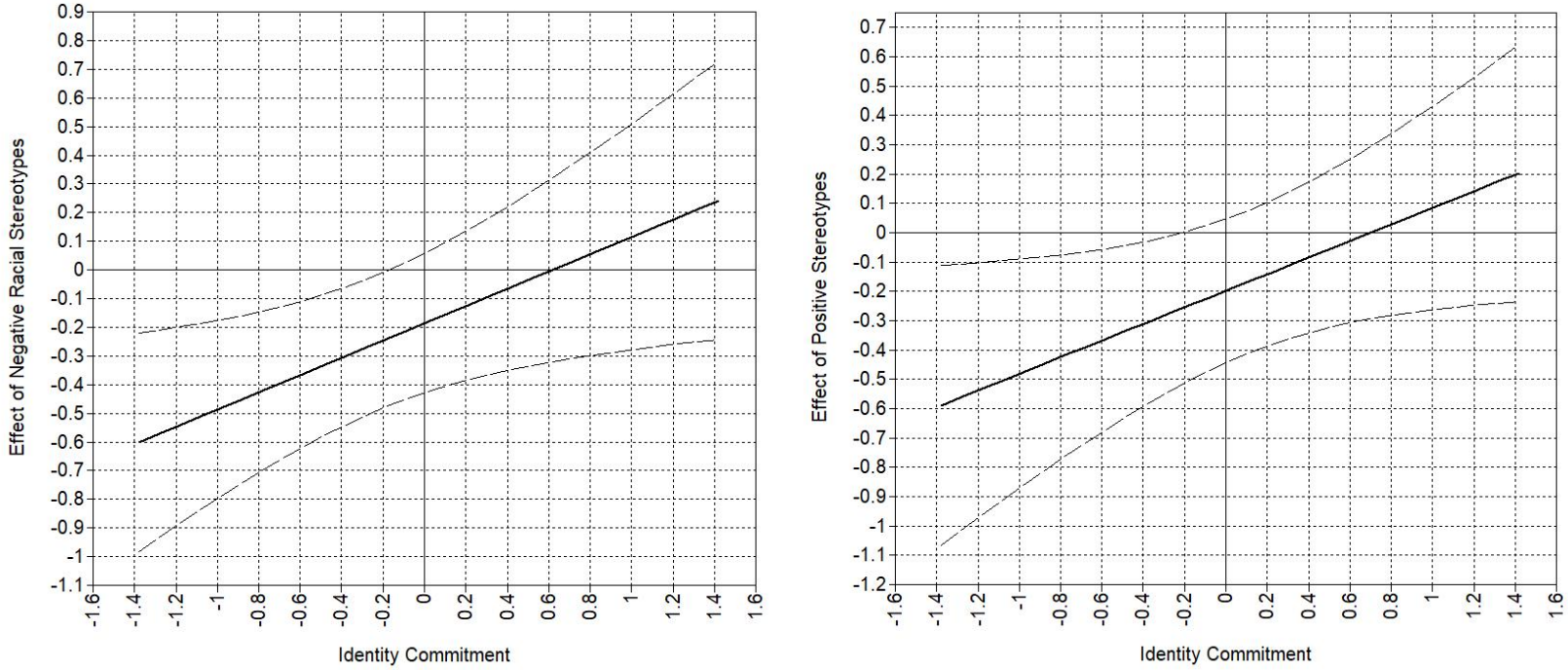
Mediation Models for Cognitive Engagement and Math Fixed Ability Mindset in Year 1 and Year 2



Note. The product of a1 and b in each model represents the indirect effect of negative stereotypes vs. neutral beliefs on test scores through the corresponding mediator. The product of a2 and b in each model represents the indirect effect of positive stereotypes vs. neutral beliefs on test scores through the corresponding mediator. The coefficients of c1 and c2 represent the direct effects of stereotypes on test scores partialling out the indirect effects. The coefficients presented in the figure are unstandardized. Standardized coefficients can be found in Tables 3 and 4. Covariates include gender, prior math achievement, school membership, school racial composition, grade level, identity commitment, identity exploration, and free/reduced-priced lunch status.
+ $p < .10$. * $p < .05$. ** $p < .01$.

Figure 3

The Plot of Positive and Negative Racial Stereotype Effects on Math Cognitive Engagement against a Range of Identity Commitment Values (from -2 SD to 2 SD)



Note. Identity commitment was mean centered with *SD* = 0.68. The solid line represents the estimated effects. The dashed lines below and above the solid line are lower and upper limits of the 95% CIs for the estimated effects, respectively. The effect given a specific identity commitment was significant if the corresponding CI does not cover 0.