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Math Motivational Belief Development During High School by Race/Ethnicity: Teachers and Parents as Predictors of Changes

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The changes in adolescents' math motivational beliefs (i.e., expectancies for success, interest, and utility value) across Grades 9–11 and the associations between these changes and adolescents' experiences with socializers (i.e., perceived teacher unfairness and parent–adolescent discussions) were examined within each of the four largest racial/ethnic groups in the United States using the High School Longitudinal Study, a nationally representative data set ($n = 19,010$; 50% female; 9% Asian; 11% Black; 18% Latine; 62% White; $M_{\text{age}} = 14.53$ in Grade 9). Cross-tabulation analyses suggested that similar developmental trends emerged within each racial/ethnic group (which were tested separately). Many adolescents maintained their high or low expectancies, interest, and utility values across Grades 9–11. Some patterns varied by belief; for example, several adolescents switched from high to low interest by Grade 11, whereas several adolescents switched from low to high utility value. Parent–adolescent discussions predicted positive changes among Asian and Latine adolescents, whereas perceived teacher unfairness predicted negative changes among Black adolescents. The findings from the present study highlight the diverse developmental trends in adolescents' motivational beliefs and the potential role of socializers as sources of strength or challenge in their motivational belief development.

Public Significance Statement

This study demonstrates that adolescents within each of the four major racial/ethnic groups in the United States displayed multiple developmental trends in their math motivational beliefs and suggests that interventions in high school could boost adolescents' math motivational beliefs, such as interest value. Additionally, our findings suggest that intervention efforts to help parents and teachers provide more equitable support may benefit adolescents, especially for those marginalized in math.

Keywords: situated expectancy-value theory, motivation, math, parents, teachers

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Racial/ethnic gaps remain in most math-intensive science, technology, engineering, and math (STEM) college majors and occupations where Black and Latine individuals are underrepresented relative to Asian and White individuals (National Science Foundation,

2019). Even in high school, Black and Latine students, on average, take fewer advanced math courses and have lower math achievement compared to Asian and White students (National Center for Education Statistics, 2022, 2023). Given that adolescents' math motivational beliefs in high school are directly associated with their subsequent STEM course-taking, college majors, or career choices, examining math motivational belief processes among diverse racial/ethnic high school adolescents is important to eliminate these persistent racial/ethnic disparities in STEM (Guo et al., 2015; Hsieh & Simpkins, 2022; Jiang et al., 2020; Seo et al., 2019; Simpkins et al., 2015a; Wang et al., 2015). Though it is critical to understand which groups are marginalized to design interventions and address structural barriers, focusing only on racial/ethnic comparisons can reinforce the challenges faced by marginalized groups and position Black and Latine students, who are racially/ethnically marginalized in math, from a deficit perspective (Causadias et al., 2018).

In order to address the persistent racial/ethnic disparities, it is equally important to examine variability *within* each racial/ethnic group as some students from marginalized racial/ethnic groups are succeeding in STEM—a fact that often gets overlooked in studies that compare racial/ethnic groups (e.g., Hsieh et al., 2021; Lee-Poon & Simpkins, 2024; Puente et al., 2021; Starr, Ramos Carranza, & Simpkins, 2022). Thus, one goal of this study was to identify

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The code behind the analyses has been made publicly available at the Open Science Framework and can be accessed at <https://osf.io/sm82t/> (Lee-Poon et al., 2024). The scripts for the present analyses were preregistered and are available on the Open Science Framework at <https://osf.io/sm82t/>.

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the unique developmental trends in students' math motivational beliefs *within* each of the four largest racial/ethnic groups in the United States (i.e., Asian, Black, Latine, and White) in an effort to describe the developmental processes and strengths experienced by each group.

The development of adolescents' motivational beliefs is shaped by the experiences they have in their immediate environments, including their interactions with teachers and parents (Eccles & Wigfield, 2020). For example, adolescents who are racially/ethnically marginalized in math may encounter more structural barriers, including more unfair treatment from their teachers, that negatively impact their motivational beliefs (Roeser et al., 2000; Wong et al., 2003). Conversely, STEM-related support from parents may help adolescents persist in STEM (Choi et al., 2015; McGee & Spencer, 2015; Starr, Ramos Carranza, & Simpkins, 2022). More studies are needed to understand families because families can be important agents that help racially/ethnically minoritized adolescents overcome challenges and unfair experiences (Umaña-Taylor & Hill, 2020). Examining social contexts that challenge or reaffirm negative stereotypes will help address the need to increase awareness of the consequences of unjust experiences in adolescence among psychologists and practitioners (Killen et al., 2016).

Scholars have underscored that there is substantial variability across individuals within each racial/ethnic group regarding their experiences with socializers (e.g., Causadias et al., 2018; Simpkins et al., 2015a). Examining the associations between adolescents' experiences and their motivational beliefs within each racial/ethnic group separately is necessary to identify the potential of socializers as sources of strength or challenge for racially/ethnically diverse adolescents. Therefore, a second goal of this study was to test the potential hindering role of experiencing injustice in academic settings (i.e., perceived teacher unfairness) and the promotive role of parental support (i.e., parent-adolescent discussions) on adolescents' math motivational belief development within each of the four largest racial/ethnic groups in the United States (i.e., Asian, Black, Latine, and White).

Developmental Trends in Adolescents' Motivational Beliefs

Situated expectancy-value theory posits that students' motivational beliefs, such as expectancies for success (i.e., expectation of success on the task), interest (i.e., enjoyment of the task), and utility value (i.e., perceived usefulness of the task), directly influence their academic performance and choices (Eccles, 2009; Eccles & Wigfield, 2020). During adolescence, these motivational beliefs are likely to change as students become more conscious of their identities and skill sets and work toward aligning their identities and goals with the societal roles or expectations for them (Eccles & Wigfield, 2020). Though prior work often suggests that, on average, students' motivational beliefs in several domains (including math) decrease from childhood to adolescence (Fredricks & Eccles, 2002; Jacobs et al., 2002; Watt, 2004), more recent work focused on adolescence suggests that the changes in adolescents' motivational beliefs may be more complex. Studies that tested whether there were multiple unique developmental trends in adolescents' math motivational beliefs (vs. testing the average trend) found that although some adolescents' beliefs decreased, others' beliefs increased or were stable (e.g., Gaspard et al., 2020; Guo et al., 2018; Petersen & Hyde, 2017). The developmental trends in motivational beliefs vary not only

across adolescents but also across the types of motivational beliefs (Petersen & Hyde, 2017; Safavian & Conley, 2016). For example, adolescents' interest, on average, declined over time, but their expectancies for success tended to remain stable and relatively high (Petersen & Hyde, 2017). More research is needed that charts these diverse developmental trends and the predictors of these trends within each racial/ethnic group to develop effective interventions for each group.

Historically, societal stereotypes for math suggest that Asian, White, and male students are expected to outperform Black, Latine, and female students (Else-Quest et al., 2013; Joseph et al., 2019). These stereotypes are likely to result in adolescents who are racially/ethnically marginalized in math (i.e., Black and Latine students) to encounter more negative social experiences that convey these negative stereotypes, which may result in negative math motivational belief development for adolescents (e.g., switching from high to low math motivation; Wang & Degol, 2017). In other words, for those marginalized in math, their deeper awareness of the negative stereotypes may induce identity threats that lead to negative academic consequences (Baysu et al., 2016; Ruck et al., 2011). In contrast, adolescents from racial/ethnic groups who are historically privileged in math (i.e., Asian and White students) may be more likely to display positive motivational belief development (e.g., maintaining high motivation). Changes in students' motivational beliefs may be pronounced during adolescence as students develop a better awareness of the stereotypes people hold and the cultural norms that exist about their racial/ethnic group (Coll et al., 1996; Spears Brown & Bigler, 2005; Wang & Degol, 2013).

Though less research charts individuals' math motivational belief development among marginalized groups, a few studies have demonstrated that not all adolescents follow the trends based on traditional stereotypes. Using the same data as the present study, one recent study tested transition probabilities of adolescents' math and science motivational beliefs and found that adolescents within each racial/ethnic group demonstrated diverse changes over time, including some who demonstrated overall high stability among marginalized groups (i.e., Black and Latine; Hsieh & Simpkins, 2022). Additionally, Lee-Poon and Simpkins (2024) tested the math motivational belief development among Latine and Asian adolescents and found not just decreasing trends but also increasing (i.e., low to high) or high/low stable trends across adolescence. They also noted that despite being historically marginalized in math, Latine adolescents did not always display larger declines in motivational beliefs compared to Asian adolescents. Parents' and teachers' behavior may be critical in helping adolescents display positive developmental trends that challenge math stereotypes (Starr, Ramos Carranza, & Simpkins, 2022). In this study, we extended prior research by testing whether multiple unique developmental trends exist in adolescents' motivational beliefs among diverse racial/ethnic groups. Particularly, we examined the processes separately within each racial/ethnic group to highlight the unique developmental trends and the contextual correlates that may hinder or foster math motivational beliefs for adolescents within each group.

Teachers' and Parents' Behaviors

According to the situated expectancy-value theory, students' motivational beliefs are shaped by their immediate settings and the broader cultural milieu (e.g., societal stereotypes and beliefs; Eccles & Wigfield, 2020; Wigfield & Eccles, 2020). The societal expectations

of the cultural milieu are communicated to students through their interactions with central socializers, including parents and teachers. Parents are critical sources of everyday academic support, and when adolescents make important academic decisions, particularly for students who are marginalized at school (Harackiewicz et al., 2012; Hill & Tyson, 2009; Starr, Tulagan, & Simpkins, 2022). Even among those marginalized in math due to race/ethnicity, parent and teacher support positively predicts their STEM motivational beliefs (Starr, Ramos Carranza, & Simpkins, 2022; Starr, Tulagan, & Simpkins, 2022). Receiving positive messages about their math ability likely promotes adolescents' motivational beliefs, whereas messages that convey doubts about their ability or differential expectations can have the opposite effect. Thus, adolescents' math motivational beliefs could change in positive or negative directions depending on their interactions with socializers.

Perceived Teacher Unfairness

Scholars argue that teachers' explicit and implicit differential treatment can negatively impact students' academic performance (McKown, 2013). That is, the signals from teachers that infer negative stereotypes (e.g., differential treatment of other students who share the same racial/ethnic identity) can negatively influence students' performance by triggering their lack of belongingness in the classroom. Roeser et al.'s (1998) school psychological environment model states that students' perceptions of the quality of their relationships with teachers (i.e., discrimination experiences and teacher supportiveness) influence their motivational belief development. In support of this model, students who perceived their teachers to treat them unfairly or disrespectfully due to their gender or race/ethnicity endorsed lower academic values than their peers (Roeser et al., 2000). Black adolescents' experiences of teacher unfairness also predicted lower expectancies for success and subjective task value beliefs in academics (Wong et al., 2003). Thus, adolescents who are racially/ethnically marginalized in math may be more likely to maintain low math motivational beliefs or switch from high to low beliefs than maintain high beliefs or switch from low to high beliefs due to their experiences of teacher unfairness.

The importance of equitable treatment from teachers has been noted in studies across various racial/ethnic groups (Lee & Simpkins, 2021; Shifrer et al., 2023; Wong et al., 2003). Using the same data set as the present study (i.e., the High School Longitudinal Study [HSLs]), Shifrer et al. (2023) found that adolescents' perceptions of equitable treatment from their teachers in Grade 9 positively predicted their concurrent math motivational beliefs regardless of adolescents' race/ethnicity and gender. Though this study highlights the importance of equitable treatment from teachers, they combined theoretically distinct motivational beliefs (i.e., expectancies for success and subjective task values) into one overall motivational construct and only tested the associations cross-sectionally at Grade 9. Lee and Simpkins (2021) also highlighted that adolescents' perceptions of teacher unfairness were negatively associated with their math performance during high school in diverse racial/ethnic groups. Still, this study only involved the Grade 9 cross-sectional data in HSLs. We extended this research by testing whether perceived teacher unfairness, a potential structural barrier, predicted adolescents' concurrent math motivational beliefs as well as changes in these beliefs (i.e., expectancies for success, interest, and utility value)

to test if the effects of teacher unfairness have a lasting impact and similarly affect adolescents' expectancies and values.

Parent-Adolescent Discussion

Eccles' (1993) parent socialization model describes that parents' supportive behaviors, such as career guidance and communication about their expectations for their children, foster students' motivational beliefs. Scholars have highlighted that parent-child STEM discussions may be particularly important during adolescence when youth are developing a sense of autonomy (e.g., Harackiewicz et al., 2012). Adolescents' discussions with their parents about their academic plans, such as selecting courses, were associated with higher expectancies for success in math, which in turn led to higher math performance among racially/ethnically diverse students in Grade 10 (Choi et al., 2015). In one longitudinal study with predominantly White youth, parents' expectations and communication with their children about academics predicted higher math interest concurrently at age 9 and smaller decreases in math interest from ages 9 to 17 (Gottfried et al., 2009).

Parental support may also function as a source of resilience and protect marginalized adolescents facing structural barriers (W. B. Chen & Gregory, 2009; Zimmerman et al., 2013). For example, in one study using HSLs data, parental support was protective for adolescents who doubted their math abilities when they felt their math teacher was unfair (Lee & Simpkins, 2021). Additionally, a recent review suggests parents' STEM support is associated with fostering racially/ethnically marginalized students' math motivational beliefs (i.e., Black and Latine students; Starr, Tulagan, & Simpkins, 2022). One qualitative study involving high-achieving Black students in STEM college majors demonstrated that students' discussions with parents about educational struggles and future academic success helped them to continue challenging themselves academically (McGee & Spencer, 2015). Also, parental support was found to positively predict Latine adolescents' motivational beliefs and their determination to persevere through challenges (Kuperminc et al., 2008; Suizzo et al., 2012). Given the strong positive associations between parental support and youth's motivational belief development, including youth who are marginalized in math, adolescents may be more likely to maintain high math beliefs or switch from low to high beliefs versus maintaining low beliefs or switching from high to low beliefs if they talk to their parents about their academics.

The Present Study

According to the situated expectancy-value theory, students' motivational beliefs are shaped by developmental processes and sociocultural environmental influences (Eccles & Wigfield, 2020). Adolescents may display diverse changes in their motivational beliefs, and these changes are theorized to be linked to their interactions with socializers, especially parents and teachers (Wigfield & Eccles, 2020). That is, though two adolescents may have similar math motivational beliefs at the start of high school, their motivational beliefs could change in different ways depending on their negative (e.g., perceiving teacher unfairness; McKown, 2013; Roeser et al., 1998) and positive experiences (e.g., talking to parents about academics; W. B. Chen & Gregory, 2009; Zimmerman et al., 2013). Depending on their experiences, students may maintain low motivational beliefs, switch

from high to low motivational beliefs, switch from low to high motivational beliefs, or maintain high motivational beliefs.

In this study, we examined adolescents' math motivational belief processes and predictors of these changes *within* each of the four largest racial/ethnic groups in the United States: Asian, Black, Latine, and White groups. By doing so, we aimed to highlight diverse changes that may exist within marginalized or privileged groups and avoid deficit-based approaches that emphasize negative development in marginalized groups (e.g., Causadias et al., 2018). We included students' social experiences in Grade 9 as predictors of adolescents' motivational belief development from Grades 9–11 because experiences during Grade 9 may be especially critical in shaping their subsequent motivational beliefs during high school (e.g., Roybal et al., 2014). For example, the experiences students have in Grade 9 may predict their ability to handle new demands and challenges as well as hardships they encounter in high school (Cohen & Smerdon, 2009; Mizelle & Irvin, 2000; Roybal et al., 2014).

First, aligned with traditional stereotypes, adolescents who are privileged in math based on their race/ethnicity (i.e., Asian and White groups) may display higher likelihoods of maintaining high motivational beliefs than switching from high to low motivational beliefs and higher likelihoods of switching from low to high motivational beliefs than maintaining low motivational beliefs. Similarly, adolescents who are marginalized in math based on their race/ethnicity (i.e., Black and Latine groups) may display the opposite patterns—higher likelihoods of switching from high to low motivational beliefs than maintaining high motivational beliefs and higher likelihoods of maintaining low motivational beliefs than switching from low to high motivational beliefs. However, more recent work suggests that some youths in each racial/ethnic group can display trends that challenge these long-held stereotypes (Hsieh & Simpkins, 2022; Lee-Poon & Simpkins, 2024). In other words, though we expected adolescents to display trends based on traditional stereotypes, we also expected some adolescents to display trends that challenge these stereotypes (e.g., maintaining high motivational beliefs among Black adolescents) across Grades 9–11 in all racial/ethnic groups.

Second, we expected adolescents' perceptions of teacher unfairness in Grade 9 to negatively predict their math motivational beliefs concurrently (i.e., low than high motivational beliefs), especially among those marginalized in math (i.e., Black and Latine groups). Conversely, we expected parent–adolescent discussions in Grade 9 to positively predict adolescents' math motivational beliefs concurrently (i.e., high than low motivational beliefs).

Third, we expected adolescents' perceptions of teacher unfairness in Grade 9 to predict higher likelihoods of maintaining low motivational beliefs or switching from high to low motivational beliefs than the other trends across Grades 9–11, especially among students marginalized in math (i.e., Black and Latine groups). Conversely, we expected parent–adolescent discussions to predict higher likelihoods of maintaining high motivational beliefs or switching from low to high motivational beliefs than the other trends across Grades 9–11 in all racial/ethnic groups.

Method

Transparency and Openness

We reported how we determined our sample size, all data exclusions, and all measures in the study, and we follow journal

article reporting standards (Appelbaum et al., 2018). Though we used the restricted version of the HSLs data set, a public data set with suppression of some data can be found at <https://nces.ed.gov/surveys/hsls09>. The scripts for the present analyses were preregistered and are available on the Open Science Framework at <https://osf.io/sm82t/>.

Participants

Data were drawn from the HSLs, a longitudinal study with a nationally representative sample of U.S. high school students. The study was designed and conducted by the National Center for Education Statistics to study high school students' educational and vocational trajectories in STEM (Ingels et al., 2011). The HSLs data set was collected through a two-stage stratified sampling design with schools as the primary sampling units. In the first stage, 944 high schools from 10 states were randomly selected. In the second stage, students in each school were randomly sampled within strata defined by race/ethnicity, resulting in a total of 25,210 participants in the base-year study. These students had parental consent to participate in the study. The present study used the data from the first two waves when students were in Grade 9 (base year) and Grade 11 (first follow-up). The use of data was approved by the Institutional Review Board of a large public university in Southern California.

Of the 25,210 participants, we sequentially excluded (a) students who had missing information on their gender or race/ethnicity or were not Asian, Black, Latine, or White ($n = 2,150$); (b) students who had missing information on motivational beliefs (i.e., expectancies for success, interest, utility value, attainment value) in both Grades 9 and 11 ($n = 2,470$); and (c) students who were missing both perceived teacher unfairness and parent–adolescent discussions ($n = 1,570$). The analytic sample consisted of 19,010 participants ($M_{\text{age}} = 14.53$ in Grade 9; 50% female). They were 9% Asian, 11% Black, 18% Latine, and 62% White.

A comparison of the analytic and the excluded sample is provided in Table S1. Of the 15 comparisons, three demonstrated at least a small effect. Compared to the excluded sample, students in the analytic sample were more likely to identify as White ($\phi = .39$) and report higher family socioeconomic status ($d = .25$) and higher math achievement ($d = .23$).

Measures

Students' math motivational beliefs were measured using the student survey administered in the Fall of Grade 9 and Spring of Grade 11. Students' perceived teacher unfairness and parent–adolescent discussions were measured in the Fall survey of Grade 9. One item for parent–adolescent discussions was measured in the parent survey in Grade 9.

Math Motivational Beliefs

Students' math expectancies for success, interest, and utility value were measured with indicators that aligned with the situated expectancy-value theory (Eccles, 2009; Eccles & Wigfield, 2020) and have been used in many prior studies (e.g., Fong et al., 2021; Hsieh & Simpkins, 2022; Jiang et al., 2020). Given that each motivational belief is a unique construct that is empirically distinct (Eccles & Wigfield, 2002; Guo et al., 2016) and prior research

suggests the trends may vary across these beliefs (e.g., Petersen & Hyde, 2017), we tested the development of each belief separately.

Expectancies for success were measured using four items on a 4-point scale ($\alpha = .89$ and $.90$): (a) “9th/11th grader is confident he/she can do excellent job on Fall 2009/Spring 2012 math tests,” (b) “9th/11th grader is certain he/she can understand Fall 2009/Spring 2012 math textbook,” (c) “9th/11th grader is certain he/she can master skills in Fall 2009/Spring 2012 math course,” and (d) “9th/11th grader is confident he/she can do excellent job on Fall 2009/Spring 2012 math assignments.”

Interest was measured using three items on a 4-point scale ($\alpha = .78$ and $.78$): “How much do you agree or disagree with the following statements about your (Fall 2009/Spring 2012) math course?”—(a) “You are enjoying this class very much,” (b) “You think this class is a waste of your time,” and (c) “You think this class is boring.”

Utility value was measured using three items on a 4-point scale ($\alpha = .78$ and $.82$): “How much do you agree or disagree with the following statements about the usefulness of your (Fall 2009/Spring 2012) math course? What students learn in this course?”—(a) “is useful for everyday life,” (b) “will be useful for college,” and (c) “will be useful for a future career.”

For all motivational beliefs, we averaged the items and then dichotomized the constructs to indicate low or high motivational beliefs (0 = *low motivational beliefs*, 1 = *high motivational beliefs*) based on a meaningful cutoff in the original response scale that had two disagree and two agree options (1 = *strongly disagree*, 2 = *disagree*, 3 = *agree*, 4 = *strongly agree*). In other words, students who agreed with statements (i.e., a three or higher) were considered to have high motivational beliefs, whereas those who disagreed with statements (i.e., a 2.99 or lower) were considered to have low motivational beliefs. By doing so, we could test whether students maintained low motivational beliefs, maintained high motivational beliefs, switched from low to high motivational beliefs, or switched from high to low motivational beliefs between Grades 9 and 11. Prior studies have utilized the same strategy to create a meaningful cutoff that distinguished adolescents with high or low motivational beliefs (e.g., Hsieh & Simpkins, 2022). As a robustness check, we also tested models with motivational beliefs on their original 4-point continuous scale.

Perceived Teacher Unfairness

Aligned with social equity theory (McKown, 2013) and Roeser et al. (1998) school psychological environment model, we measured students’ perceptions of teacher unfairness and disrespect in Grade 9 using the following three items on a 4-point scale ($\alpha = .80$): (a) “9th grade math teacher treats students with respect,” (b) “9th grade math teacher treats every student fairly,” and (c) “9th grade math teacher treats some kids better than others” (1 = *strongly agree*, 4 = *strongly disagree*). If applicable, items were recoded such that a high score indicated high perceived teacher unfairness. A composite score of perceived teacher unfairness was calculated by taking the mean of these three items. Previous studies examining unfair treatment by teachers have used similar items where participants responded to whether they perceived their teacher to treat students unfairly and disrespectfully (e.g., Gini et al., 2018; Lee & Simpkins, 2021; Lenzi et al., 2014).

Parent–Adolescent Discussion

Aligned with Eccles’ (1993) parent socialization model and Hill and Tyson’s (2009) definition, we measured parent–adolescent discussions in Grade 9 using seven items: (a) 9th grader talked to (mother/father) about math courses to take in 2009–2010,” (b) “9th grader talked to (mother/father) about going to college,” (c) “9th grader talked to (mother/father) about adult jobs/careers,” and (d) “Parents discussed STEM program or article with 9th grader in last year” (0 = *no*, 1 = *yes*). A composite score of parent–adolescent discussions was calculated by taking the mean of these seven items. Previous studies examining parental support via conversations have used similar items (e.g., Fan & Williams, 2010; Starr, Ramos Carranza, & Simpkins, 2022).

Race/Ethnicity

Students provided information on their race/ethnicity (Asian, Black, Latine, White, Native Hawaiian/Pacific Islander, American Indian/Alaska Native, or more than one race). In this study, we included participants who identified as Asian, Black, Latine, or White.

Background Variables

Background variables included gender (0 = *male*, 1 = *female*), family socioeconomic status (i.e., a composite measure of parents’ education, occupation, and family income created by HSLS:09 staff; range: -1.93 to 2.88 ; Ingels et al., 2011), and Grade 9 achievement (i.e., a criterion-referenced measure of achievement on algebraic reasoning assessment; range: 0 – 69.93 ; Ingels et al., 2011). Adolescents’ achievement scores were based on an achievement test developed and administered by HSLS, which tested students on six algebraic content domains, such as students’ understanding of the language of algebra or equations, and four algebraic processes, such as solving algebraic problems. The item response theory-estimated reliability was 0.92 for the items. The unidimensionality of the test items was tested through a confirmatory factor analysis (Ingels et al., 2011).

We controlled for gender, family socioeconomic status, and students’ prior achievement in our analyses. Gender was added as a background variable because math is a domain where stereotypes have historically persisted toward gender as well as race/ethnicity (Else-Quest et al., 2013; Nosek & Smyth, 2011). Male and female adolescents from each racial/ethnic group may have different experiences in math and display varying motivational belief development (Wang & Degol, 2017). Additionally, adolescents’ family socioeconomic status and their prior performance can influence their motivational belief development (Eccles & Wigfield, 2020). Given that racial/ethnic disparities have often been found in students’ math performance (e.g., National Science Foundation, 2019) and family income (e.g., Perry et al., 2012), we controlled for these factors.

Plan of Analysis

Descriptive statistics, cross-tabulations, and logistic regression analyses were conducted using Stata15. In all our analyses, we included sampling weights to account for the nonresponse rate in the sampling process, and strata and primary sampling unit to correct the standard errors from the stratified design of the data set. The scripts

for the present analyses were preregistered and are available on the Open Science Framework at <https://osf.io/sm82t/>. From the entire analytic sample, 14,320 participants had complete data whereas 4,690 participants were missing some data (Table S2). Of the 15 comparisons, three demonstrated at least a small effect. Compared to the sample with some missing data, the sample with complete data reported more parent–adolescent discussions ($d = .22$), higher family socioeconomic status ($d = .32$), and higher math achievement ($d = .46$). Missing data were handled using multiple imputation using 30 data sets (Enders, 2022). The findings from logistic regression analyses were obtained using listwise deletion to report odds ratios, but we included the results using multiple-imputed data as a robustness check. The results were largely consistent, which we explain further in the Results section.

Our first research question was to examine the developmental changes of expectancies for success, interest, and utility value in math across Grades 9–11 *within* each of the four racial/ethnic groups (i.e., Asian, Black, Latine, and White). Models were estimated separately for each motivational belief and each racial/ethnic group. After preassigning participants to low/high group, we mapped out the stability/change patterns in adolescents' motivational beliefs using cross-tabulation (i.e., maintain low; switch from low to high; switch from high to low; maintain high; Janson & Mathiesen, 2008). In other words, we examined the frequencies of participants belonging to either high or low motivational beliefs in Grades 9 and 11 and the stability and change in motivational beliefs across Grades 9–11.

Our second research question was to examine the associations between perceived teacher unfairness and parent–adolescent discussions with adolescents' motivational beliefs in Grade 9. Logistic regression models were estimated with perceived teacher unfairness, parent–adolescent discussions, and background variables (i.e., prior achievement, family socioeconomic status, and gender) with Grade 9 motivational beliefs as the outcome *within* each racial/ethnic group. As a robustness check, we also tested two additional models: (a) these same models without including background variables and (b) these models (including background variables) predicting Grade 9 motivational beliefs on their original 4-point continuous scale.

Our third research question was to examine the associations between perceived teacher unfairness and parent–adolescent discussions with the changes across Grades 9–11. Again, logistic regression models were estimated with perceived teacher unfairness, parent–adolescent discussions, and background variables (i.e., prior achievement, family socioeconomic status, and gender) *within* each racial/ethnic group. With Grade 11 motivational beliefs as the outcome, two models were estimated in each racial/ethnic group: (a) among adolescents with high motivational beliefs in Grade 9 and (b) among adolescents with low motivational beliefs in Grade 9. By doing so, we tested whether adolescents maintained high motivational beliefs or switched from high to low motivational beliefs from Grades 9–11 and whether adolescents maintained low motivational beliefs or switched from low to high motivational beliefs from Grades 9–11. As a robustness check, we also tested the same models without including background variables and with background variables but using Grade 11 motivational beliefs on their original 4-point continuous scale.

Results

Table 1 shows the descriptive statistics, and Tables 2 and 3 display the correlations among the key variables separately for Asian, Black,

Table 1
Descriptive Statistics Within Each Race/Ethnicity

Variable	Asian adolescent			Black adolescent			Latine adolescent			White adolescent						
	<i>n</i>	<i>M</i> (<i>SD</i>)	Skew	Kurtosis	<i>n</i>	<i>M</i> (<i>SD</i>)	Skew	Kurtosis	<i>n</i>	<i>M</i> (<i>SD</i>)	Skew	Kurtosis				
Grade 9																
Expectancies for success	1,480	0.69 (0.40)	−0.82	1.67	1,880	0.64 (0.48)	−0.59	1.34	3,000	0.55 (0.50)	−0.19	1.04	10,740	0.57 (0.50)	−0.27	1.07
Interest	1,490	0.64 (0.48)	−0.58	1.33	1,880	0.61 (0.49)	−0.45	1.20	3,000	0.58 (0.49)	−0.31	1.10	10,740	0.53 (0.50)	−0.13	1.02
Utility value	1,480	0.77 (0.42)	−1.30	2.68	1,870	0.83 (0.38)	−1.73	3.99	2,980	0.78 (0.42)	−1.33	2.77	10,680	0.69 (0.46)	−0.84	1.71
Grade 11																
Expectancies for success	1,460	0.59 (0.49)	−0.38	1.15	1,860	0.55 (0.50)	−0.19	1.03	2,910	0.48 (0.50)	0.07	1.01	10,400	0.47 (0.50)	0.10	1.01
Interest	1,460	0.56 (0.50)	−0.24	1.06	1,860	0.46 (0.50)	0.14	1.02	2,910	0.47 (0.50)	0.12	1.02	10,410	0.41 (0.49)	0.38	1.14
Utility value	1,450	0.88 (0.33)	−2.31	6.34	1,860	0.87 (0.34)	−2.17	5.70	2,920	0.84 (0.37)	−1.85	4.43	10,410	0.81 (0.39)	−1.57	3.46
Perceived teacher unfairness	1,470	1.78 (0.59)	0.36	2.88	1,870	1.82 (0.67)	0.70	3.46	2,990	1.84 (0.63)	0.50	3.24	10,720	1.86 (0.65)	0.58	3.37
Parent–adolescent discussions	1,650	0.67 (0.31)	−0.71	2.42	2,140	0.60 (0.30)	−0.30	2.13	3,400	0.58 (0.31)	−0.30	2.09	11,730	0.67 (0.30)	−0.62	2.38
Female	1,660	0.49 (0.50)	0.03	1.00	2,160	0.49 (0.50)	0.06	1.00	3,430	0.50 (0.50)	−0.01	1.00	11,770	0.49 (0.50)	0.03	1.00
Math achievement	1,630	48.62 (12.11)	−0.45	2.71	2,130	34.80 (10.95)	0.23	2.26	3,380	37.02 (11.14)	0.07	2.34	11,610	41.47 (11.49)	−0.15	2.46
Socioeconomic status	1,640	0.38 (0.89)	0.10	2.53	2,130	−0.15 (0.73)	0.47	3.28	3,400	−0.38 (0.73)	0.71	3.46	11,640	0.20 (0.74)	0.34	2.92

Note. Sample size rounded to the nearest tens place in accordance to the NCES regulations. Each motivational belief variables are dichotomized (e.g., 0 = low expectancies for success, 1 = high expectancies for success). *Source.* U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, High School Longitudinal Study of 2009 (HLS:09), Base Year and First Follow-Up. NCES = National Center for Education Statistics.

Table 2
Bivariate Correlations for Latine (Below the Diagonal) and Black (Above the Diagonal) Adolescents

Variable	1	2	3	4	5	6	7	8	9	10	11
1. Grade 9 expectancies for success	—	.31*	.20*	.21*	.15*	.07*	-.15*	.09*	-.09*	.16*	.02
2. Grade 9 interest	.30*	—	.19*	.10*	.21*	.03	-.34*	.12*	.04	.14*	.03
3. Grade 9 utility value	.21*	.24*	—	.04	.11*	.13*	-.13*	.06	-.01	-.04	-.07*
4. Grade 11 expectancies for success	.26*	.15*	.09*	—	.37*	.15*	-.06	.06*	-.05	.15*	.02
5. Grade 11 interest	.15*	.18*	.14*	.41*	—	.17*	-.12*	.06	.01	.10*	-.01
6. Grade 11 utility value	.15*	.07*	.15*	.18*	.22*	—	-.02	-.01	-.01	.02	-.05
7. Perceived teacher unfairness	-.18*	-.36*	-.13*	-.07*	-.10*	-.06*	—	-.10*	-.04	-.10*	-.05
8. Parent-adolescent discussions	.12*	.11*	.07*	.11*	.07*	.05*	-.12*	—	.06*	.23*	.20*
9. Female	-.10*	.04	-.04	-.10*	.00	-.05*	.01	.05*	—	.03	-.01
10. Math achievement	.22*	.10*	.00	.19*	.13*	.08*	-.09*	.25*	.02	—	.34*
11. Socioeconomic status	.11*	.00	-.07*	.10*	-.01	-.03	-.02	.27*	.03	.35*	—

Note. Source. U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, High School Longitudinal Study of 2009 (HLS:09), Base Year and First Follow-Up.
* $p < .01$.

Latine, and White adolescents. In Grade 9, more than 50% of the adolescents from all racial/ethnic groups reported high expectancies for success, interest, and utility value. In Grade 11, more than 50% of Asian and Black adolescents, 48% of Latine adolescents, and 47% of White adolescents reported high expectancies for success. For interest, 56% of Asian adolescents, 46% of Black adolescents, 47% of Latine adolescents, and 41% of White adolescents displayed high interest in Grade 11. For utility value, more than 80% of the adolescents reported high utility value in Grade 11 in all racial/ethnic groups. In all races/ethnicities, adolescents' motivational beliefs were often positively correlated with each other ($r = .07-.43, p < .01$). Mostly, perceived teacher unfairness was negatively ($r = -.06$ to $-.36, p < .01$) and parent-adolescent discussions were positively ($r = .05-.15, p < .01$) correlated with adolescents' motivational beliefs.

Developmental Trends in Adolescents' Motivational Beliefs by Racial/Ethnic Group

We examined the developmental trends of adolescents' expectancies for success, interest, and utility value in math across Grades 9-11 within each racial/ethnic group (i.e., Asian, Black, Latine, and

White; Figures 1-4). Below, we describe the frequencies of stability and change in adolescents' motivational beliefs by race/ethnicity.

Asian Adolescents

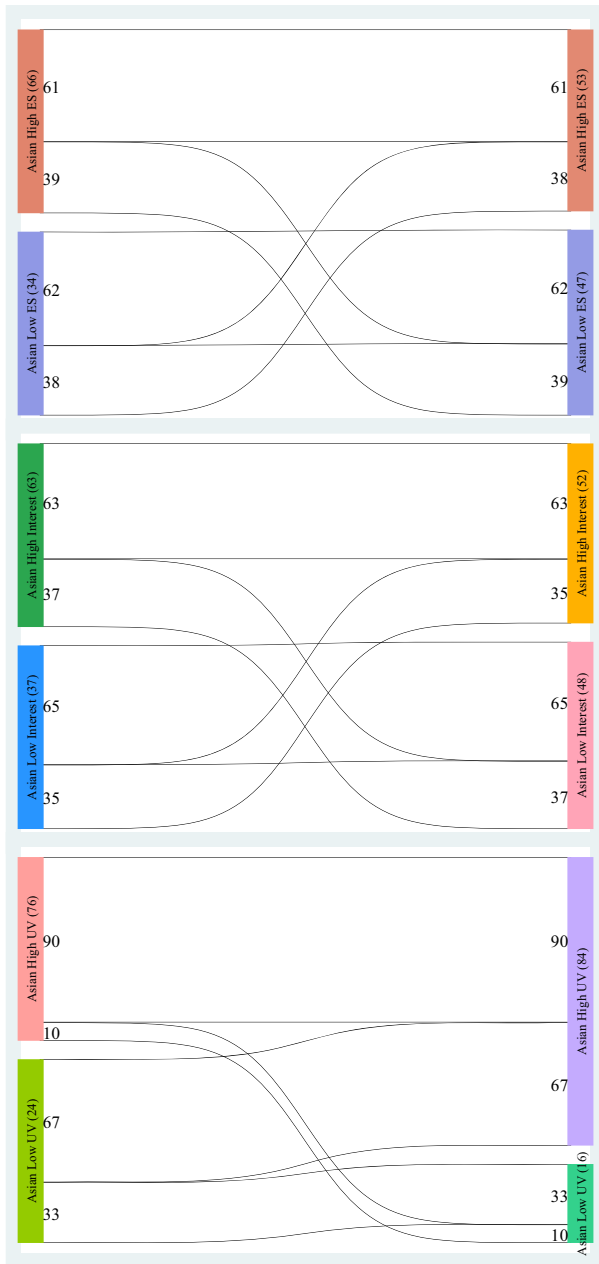
The developmental trends in expectancies for success, interest, and utility value for Asian adolescents ($n = 1,650$) are displayed in Figure 1. Sixty-six percent reported high expectancies for success, and 34% reported low expectancies for success in Grade 9. Of those with high expectancies for success in Grade 9, 61% maintained a high level whereas 39% switched from high to low beliefs. Of those with low expectancies for success in Grade 9, 38% switched from low to high beliefs whereas 62% maintained their low expectancies for success. Sixty-three percent reported high interest, and 37% reported low interest in Grade 9. Of those with high interest in Grade 9, 63% maintained a high level whereas 37% switched from high to low beliefs. Of those with low interest, 35% switched from low to high beliefs whereas 65% maintained their low interest. Seventy-six percent reported high utility value, and 24% reported low utility value in Grade 9. Of those with high utility value in Grade 9, 90% maintained a high level whereas 10% switched from high to low beliefs. Of those with low utility value, 67% switched from low to high beliefs whereas 33% maintained their low utility value.

Table 3
Bivariate Correlations for White (Below the Diagonal) and Asian (Above the Diagonal) Adolescents

Variable	1	2	3	4	5	6	7	8	9	10	11
1. Grade 9 expectancies for success	—	.26*	.19*	.24*	.14*	.10*	-.20*	.13*	-.07*	.25*	.14*
2. Grade 9 interest	.33*	—	.25*	.09*	.20*	.04	-.30*	.07*	.04	.06	.02
3. Grade 9 utility value	.23*	.30*	—	.04	.13*	.20*	-.19*	-.01	-.04	-.06	-.13*
4. Grade 11 expectancies for success	.28*	.15*	.11*	—	.35*	.17*	-.08*	.09*	-.10*	.20*	.05
5. Grade 11 interest	.20*	.24*	.15*	.43*	—	.19*	-.10*	.05	-.06	.14*	.02
6. Grade 11 utility value	.11*	.14*	.19*	.22*	.25*	—	-.06	.02	-.04	.02	-.06
7. Perceived teacher unfairness	-.20*	-.36*	-.19*	-.08*	-.11*	-.07*	—	-.11*	.00	-.12*	-.05
8. Parent-adolescent discussions	.15*	.14*	.09*	.09*	.10*	.05*	-.11*	—	.05	.28*	.33*
9. Female	-.10*	.02	-.03*	-.10*	-.01	-.02	-.01	.06*	—	-.01	.04
10. Math achievement	.27*	.15*	.02	.24*	.17*	.08*	-.11*	.29*	-.01	—	.44*
11. Socioeconomic status	.14*	.05*	-.03*	.12*	.08*	.01	-.06*	.26*	-.01	.41*	—

Note. Source. U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, High School Longitudinal Study of 2009 (HLS:09), Base Year and First Follow-Up.
* $p < .01$.

Figure 1
Proportions and Latent Transition Probabilities for Motivational Beliefs From Grades 9–11 Among Asian Adolescents



Note. Numbers indicate the percentages of students. ES = expectancies for success; UV = utility value. $n = 1,650$ for Asian. *Source.* U.S. Department of Education, Institute of Educational Sciences, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSL:09), Base Year. See the online article for the color version of this figure.

Black Adolescents

The developmental trends in expectancies for success, interest, and utility value for Black adolescents ($n = 2,140$) are displayed in Figure 2. Sixty percent reported high expectancies for success, and

40% reported low expectancies for success in Grade 9. Of those with high expectancies for success in Grade 9, 62% maintained a high level whereas 38% switched from high to low beliefs. Of those with low expectancies for success, 38% switched from low to high beliefs whereas 62% maintained their low expectancies for success. Fifty-eight percent reported high interest, and 42% reported low interest in Grade 9. Of those with high interest in Grade 9, 55% maintained a high level whereas 45% switched from high to low beliefs. Of those with low interest, 34% switched from low to high beliefs whereas 66% maintained their low interest. Eighty-three percent reported high utility value, and 17% reported low utility value in Grade 9. Of those with high utility value in Grade 9, 92% maintained a high level whereas 8% switched from high to low beliefs. Of those with low utility value, 77% switched from low to high beliefs whereas 23% maintained their low utility value.

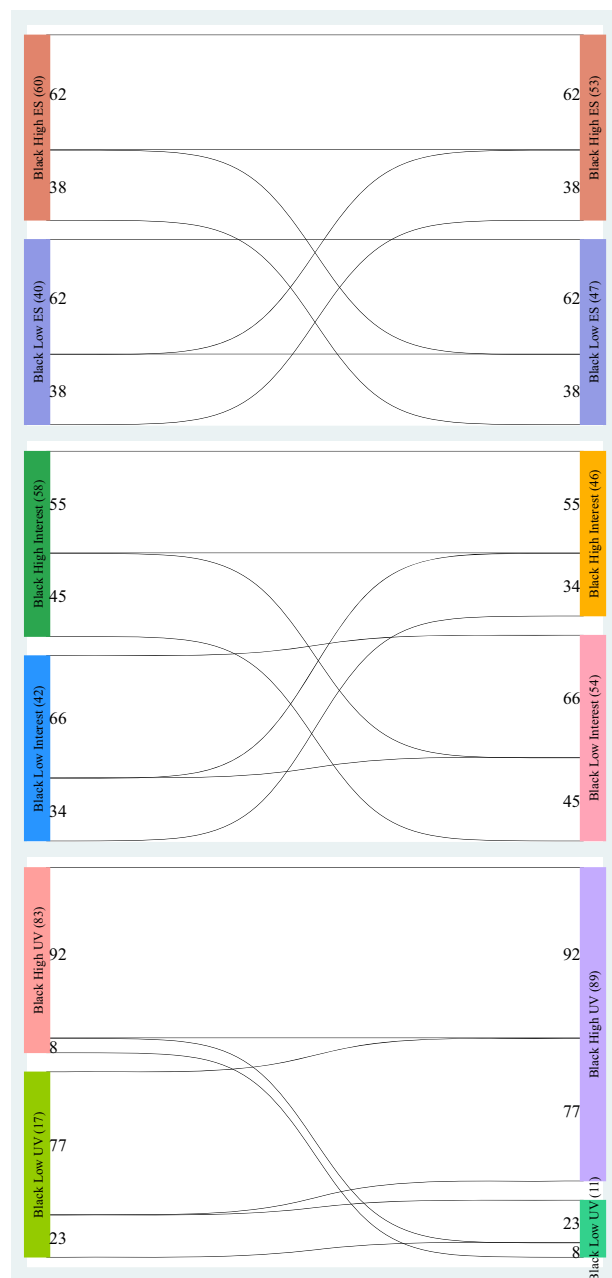
Latine Adolescents

The developmental trends in expectancies for success, interest, and utility value for Latine adolescents ($n = 3,430$) are displayed in Figure 3. Fifty-three percent reported high expectancies for success, and 47% reported low expectancies for success in Grade 9. Of those with high expectancies for success in Grade 9, 56% maintained a high level whereas 44% switched from high to low beliefs. Of those with low expectancies for success, 31% switched from low to high beliefs whereas 69% maintained their low expectancies for success. Fifty-five percent reported high interest, and 45% reported low interest in Grade 9. Of those with high interest in Grade 9, 53% maintained a high level whereas 47% switched from high to low beliefs. Of those with low interest, 34% switched from low to high beliefs whereas 66% maintained their low interest. Seventy-seven percent reported high utility value, and 23% reported low utility value in Grade 9. Of those with high utility value in Grade 9, 86% maintained a high level whereas 14% switched from high to low beliefs. Of those with low utility value, 73% switched from low to high beliefs whereas 27% maintained their low utility value.

White Adolescents

The developmental trends in expectancies for success, interest, and utility value for White adolescents ($n = 11,770$) are displayed in Figure 4. Fifty-seven percent reported high expectancies for success, and 43% reported low expectancies for success in Grade 9. Of those with high expectancies for success in Grade 9, 58% maintained a high level whereas 42% switched from high to low beliefs. Of those with low expectancies for success in Grade 9, 32% switched from low to high beliefs whereas 68% maintained their low expectancies for success. Fifty-three percent reported high interest, and 47% reported low interest in Grade 9. Of those with high interest in Grade 9, 50% maintained a high level whereas 50% switched from high to low beliefs. Of those with low interest, 28% switched from low to high beliefs whereas 72% maintained their low interest. Seventy-one percent reported high utility value, and 29% reported low utility value in Grade 9. Of those with high utility value in Grade 9, 86% maintained a high level whereas 14% switched from high to low beliefs. Of those with low utility value, 71% switched from low to high beliefs whereas 29% maintained their low utility value.

Figure 2
Proportions and Latent Transition Probabilities for Motivational Beliefs From Grades 9–11 Among Black Adolescents



Note. Numbers indicate the percentages of students. ES = expectancies for success; UV = utility value. $n = 2,140$ for Black. *Source.* U.S. Department of Education, Institute of Educational Sciences, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSL:09), Base Year. See the online article for the color version of this figure.

Summary

For expectancies for success, though there were more adolescents with high expectancies for success than low expectancies for success in Grade 9 in each racial/ethnic group, the reverse was the case in the

Latine and White groups in Grade 11. This shift was likely due to two processes: (a) Many Latine and White adolescents with low expectancies for success in Grade 9 maintained their low expectancies for success in Grade 11 (69% for Latine and 68% for White), and (b) almost half of the adolescents with high expectancies for success in Grade 9 switched to low expectancies for success (44% for Latine and 42% for White) by Grade 11. In the Asian and Black groups, many adolescents maintained their high expectancies for success across Grades 9–11 (61% for Asian and 62% for Black).

For interest, though more than 50% of the adolescents had high interest in Grade 9 in all racial/ethnic groups, the trend reversed by Grade 11 among Black, Latine, and White adolescents. This shift was likely due, in part, to the fact that the majority of adolescents with low interest in Grade 9 maintained their low level rather than switch to high interest by Grade 11 in all racial/ethnic groups (i.e., 65%–72%) and that almost half of the Black, Latine, and White adolescents who started with high interest switched to low interest by Grade 11 (i.e., 45%–50%). In the Asian group, many adolescents with high interest in Grade 9 (63%) maintained their high interest in Grade 11.

For utility value, most adolescents with high utility value in Grade 9 maintained their high level than switch to low utility value by Grade 11 in all races/ethnicities (i.e., 86%–92%). Even among adolescents who held low utility value in Grade 9, many of them switched to high utility values by Grade 11 (i.e., 67%–77%).

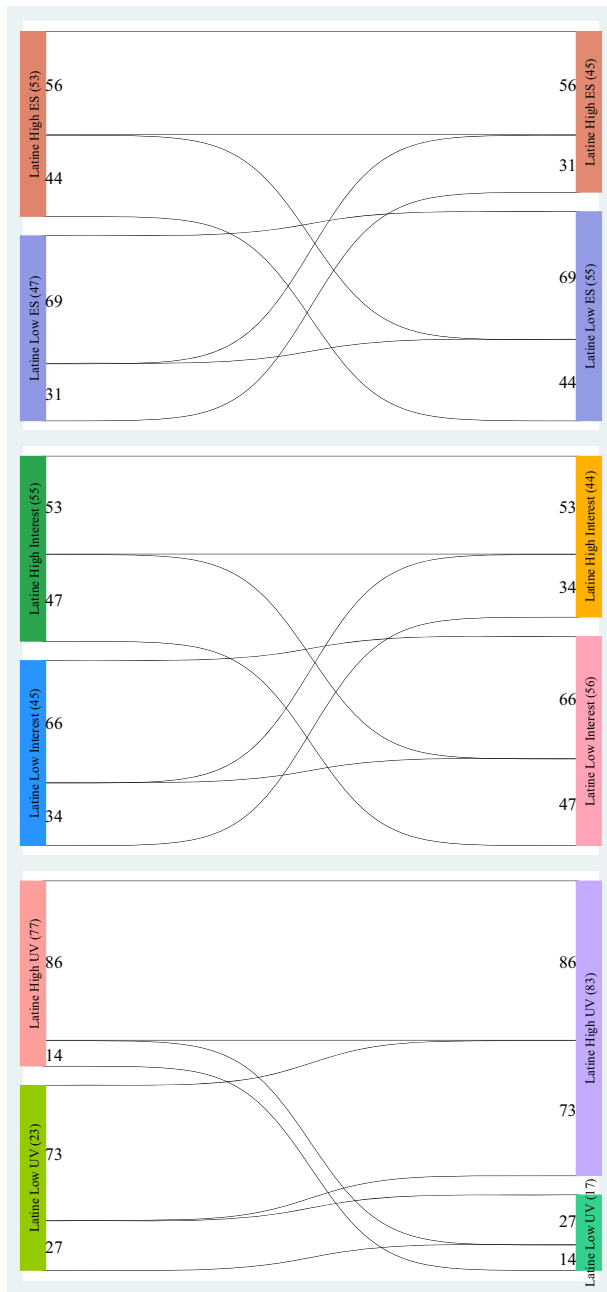
Grade 9 Motivational Beliefs and Their Associations With Perceived Teacher Unfairness and Parent–Adolescent Discussion

Subsequently, we examined the extent to which perceived teacher unfairness and parent–adolescent discussions predicted adolescents' motivational beliefs in Grade 9 controlling for prior achievement, family socioeconomic status, and gender in each race/ethnicity (Table 4). In all races/ethnicities, perceived teacher unfairness predicted lower odds of displaying high motivational beliefs in Grade 9 ($OR = .56$ [.51, .61] – $.69$ [.49, .96] for expectancies for success; $OR = .28$ [.25, .30] – $.34$ [.26, .44] for interest; $OR = .46$ [.34, .64] – $.79$ [.63, 1.00] for utility value). Parent–adolescent discussions significantly predicted higher odds of displaying high motivational beliefs in Grade 9 among Latine adolescents ($OR = 2.42$ [1.32, 4.45] for expectancies for success; $OR = 2.25$ [1.27, 3.98] for interest; $OR = 2.58$ [1.59, 4.19] for utility value) and White adolescents ($OR = 1.58$ [1.29, 1.95] for expectancies for success; $OR = 2.23$ [1.82, 2.73] for interest; $OR = 2.04$ [1.62, 2.56] for utility value). Parent–adolescent discussions did not predict motivational beliefs in Grade 9 among Asian and Black adolescents ($p = ns$). As a robustness check, we also tested the models without the background variables, with motivational beliefs on a continuous scale, and with multiple-imputed data and found largely similar results (Tables S3–S5).

Changes in Motivational Beliefs and Their Associations With Perceived Teacher Unfairness and Parent–Adolescent Discussion

In addition, we examined the extent to which perceived teacher unfairness and parent–adolescent discussions predicted the changes

Figure 3
Proportions and Latent Transition Probabilities for Motivational Beliefs From Grades 9–11 Among Latine Adolescents



Note. Numbers indicate the percentages of students. ES = expectancies for success; UV = utility value. $n = 3,430$ for Latine. *Source.* U.S. Department of Education, Institute of Educational Sciences, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSL:09), Base Year. See the online article for the color version of this figure.

in adolescents' motivational beliefs from Grades 9–11 in each race/ethnicity controlling for prior achievement, family socioeconomic status, and gender (Tables 5 and 6). The main associations were largely consistent when we tested the associations without the

background variables, with Grade 11 motivational beliefs on a continuous scale, and with multiple-imputed data (Tables S6–S10). One exception was that perceived teacher unfairness was only marginally related to maintaining high interest among Black adolescents using multiple-imputed data.

Asian Adolescents

Perceived teacher unfairness was not associated with changes in adolescents' expectancies for success, interest, or utility value. Parent–adolescent discussions were not associated with any changes in interest or utility value, but they were associated with higher odds of switching from low to high expectancies for success rather than maintaining low levels among adolescents with low expectancies for success in Grade 9, $OR = 4.07$ [1.44, 11.46].

Black Adolescents

Perceived teacher unfairness was not associated with changes in adolescents' expectancies for success or utility value, but it was associated with lower odds of maintaining high interest than switching from high to low levels among adolescents with high interest in Grade 9, $OR = .75$ [.56, .99]. Parent–adolescent discussions were not associated with any changes in expectancies for success, interest, or utility value.

Latine Adolescents

Perceived teacher unfairness was not associated with changes in adolescents' expectancies for success, interest, or utility value. Parent–adolescent discussions were not associated with any changes in interest or utility value, but they were associated with higher odds of maintaining high expectancies for success rather than switching from high to low levels among adolescents with high expectancies for success in Grade 9, $OR = 3.00$ [1.11, 8.11].

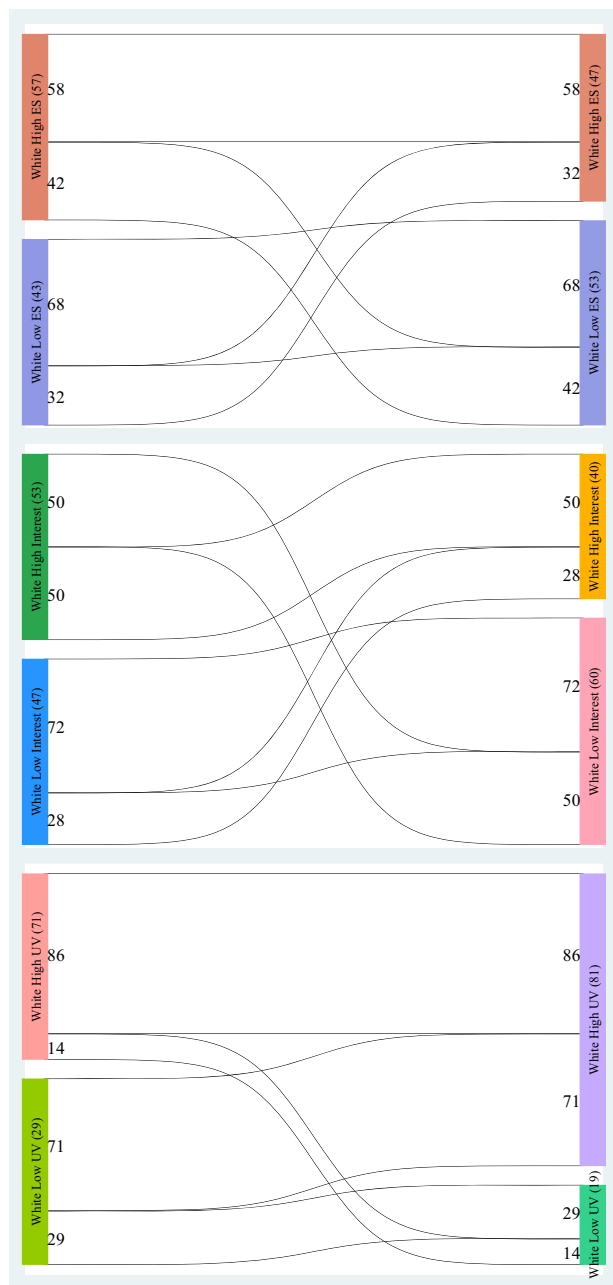
White Adolescents

Perceived teacher unfairness was not associated with changes in expectancies for success or interest, but it was associated with lower odds of maintaining high utility value than switching from high to low levels among adolescents with high utility value in Grade 9, $OR = .75$ [.65, .87]. Parent–adolescent discussions were not associated with any changes in expectancies for success or utility value, but they were associated with higher odds of maintaining high interest than switching from high to low levels among adolescents with high interest in Grade 9, $OR = 1.30$ [1.01, 1.65], and with higher odds of switching from low to high interest than maintaining low interest among adolescents with low interest in Grade 9, $OR = 1.34$ [1.00, 1.79].

Summary

Many longitudinal associations between socializers' behaviors and adolescents' motivational beliefs were not statistically significant though some significant associations emerged. Perceived teacher unfairness was associated with lower odds of maintaining high interest versus switching from high to low levels among Black adolescents and lower odds of maintaining high utility value versus switching from high to low levels among White adolescents. Parent–adolescent

Figure 4
Proportions and Latent Transition Probabilities for Motivational Beliefs From Grades 9–11 Among White Adolescents



Note. Numbers indicate the percentages of students. ES = expectancies for success; UV = utility value. $n = 11,770$ for White. *Source.* U.S. Department of Education, Institute of Educational Sciences, National Center for Education Statistics, High School Longitudinal Study of 2009 (HLSL:09), Base Year. See the online article for the color version of this figure.

discussions were associated with higher odds of switching from low to high expectancies for success versus maintaining low levels among Asian adolescents and higher odds of maintaining high expectancies for success versus switching from high to low levels among Latine

adolescents. Parent–adolescent discussions were also associated with higher odds of maintaining high interest versus switching from high to low levels and with higher odds of switching from low to high interest versus maintaining low interest among White adolescents.

Discussion

In this study, we examined the motivational belief development from Grades 9–11 in four racial/ethnic groups (i.e., Asian, Black, Latine, and White) and the extent to which perceived teacher unfairness and parent–adolescent discussions were associated with adolescents’ motivational belief development. We found multiple distinct developmental trends in each racial/ethnic group. Perceived teacher unfairness and parent–adolescent discussions were found to significantly predict motivational belief development for some groups, but not all. Our findings highlight that not all students decrease in their motivational beliefs as suggested by many prior studies focused on describing the average trend (e.g., Jacobs et al., 2002) and that socializers likely matter in shaping adolescents’ motivational belief development.

Developmental Trends in Adolescents’ Expectancies for Success and Interest

Similar developmental trends were found across expectancies for success and interest in each of the four racial/ethnic groups. Aligned with prior research that documented decreases in motivational beliefs to be more typical (Fredricks & Eccles, 2002; Jacobs et al., 2002; Nagy et al., 2010), some adolescents who had high beliefs in Grade 9 moved from having high to low beliefs by Grade 11 for expectancies for success (38%–44%) and interest (37%–50%) in all groups. These adolescents, who initially had high beliefs in Grade 9, may demonstrate declines because they find math courses more challenging and difficult during high school compared to middle school (Petersen & Hyde, 2017). Adolescents from marginalized groups may display decreases (i.e., Latine and Black students) due to their placement in lower math tracks, low-quality interactions with social agents, and limited resources (Martin, 2009). For example, math experiences typically are less interesting in lower track math courses as the class materials tend to be more repetitive and adolescents tend to have lower quality relationships with their teachers (McKown, 2013). Intervention efforts in academic environments may be helpful in boosting expectancies for success and interest in adolescents, especially among those marginalized in math.

However, more adolescents displayed stability than change during this period. In all racial/ethnic groups, we found that 50%–63% of adolescents maintained high beliefs (56%–62% for expectancies for success, 50%–63% for interest) and 62%–72% of adolescents maintained low beliefs (62%–69% for expectancies for success, 65%–72% for interest) from Grades 9–11. Adolescents are often placed into math course tracking based on their ability in middle school, which often is stable throughout high school—these experiences could serve to reinforce their expected ability in math (Simpkins et al., 2006; Wang, 2012). Additionally, given that our participants were in high school, it may be that some adolescents have already identified with the sociocultural expectations toward them and internalized these beliefs (Spears Brown & Bigler, 2005; Wang & Degol, 2013). For example, across both expectancies for success and

Table 4
Logistic Regression Results With Grade 9 Motivational Beliefs as Outcomes Within Each Race/Ethnicity

Variable	High expectancy for success in Grade 9 (vs. low expectancy for success)	High interest in Grade 9 (vs. low interest)	High utility value in Grade 9 (vs. low utility value)
	OR [95% CI]	OR [95% CI]	OR [95% CI]
Asian (n = 1,470)			
Perceived teacher unfairness	0.63 [0.45, 0.88]**	0.30 [0.20, 0.46]***	0.47 [0.34, 0.67]***
Parent-adolescent discussions	1.90 [.91, 4.00]	0.96 [0.41, 2.23]	1.19 [0.44, 3.23]
Female	0.61 [0.36, 1.03]	1.04 [0.74, 1.44]	0.58 [0.39, 0.86]**
Prior achievement	1.04 [1.02, 1.06]***	1.00 [0.99, 1.02]	1.00 [0.97, 1.03]
Socioeconomic status	1.05 [0.76, 1.44]	0.92 [0.69, 1.22]	0.61 [0.46, 0.81]***
Black (n = 1,860)			
Perceived teacher unfairness	0.65 [0.50, 0.84]**	0.34 [0.26, 0.44]***	0.46 [0.34, 0.64]***
Parent-adolescent discussions	1.28 [0.63, 2.56]	1.41 [0.74, 2.67]	1.37 [0.67, 2.79]
Female	0.96 [0.65, 1.43]	1.23 [0.86, 1.77]	0.89 [0.53, 1.49]
Prior achievement	1.03 [1.01, 1.05]***	1.03 [1.00, 1.05]*	0.99 [0.97, 1.01]
Socioeconomic status	0.83 [0.60, 1.14]	0.73 [0.56, 0.94]*	0.75 [0.57, 0.99]*
Latine (n = 2,980)			
Perceived teacher unfairness	0.69 [0.49, 0.96]*	0.30 [0.24, .37]***	0.79 [0.63, 1.00]*
Parent-adolescent discussions	2.42 [1.32, 4.45]**	2.25 [1.27, 3.98]**	2.58 [1.59, 4.19]***
Female	0.62 [0.47, 0.83]**	1.04 [0.80, 1.34]	0.91 [0.63, 1.34]
Prior achievement	1.04 [1.02, 1.05]***	1.02 [1.00, 1.04]	0.99 [0.98, 1.01]
Socioeconomic status	0.91 [0.75, 1.10]	0.81 [0.65, 1.00]*	0.63 [0.49, 0.80]***
White (n = 10,810)			
Perceived teacher unfairness	0.56 [0.51, 0.61]***	0.28 [0.25, 0.30]***	0.52 [0.47, 0.57]***
Parent-adolescent discussions	1.58 [1.29, 1.95]***	2.23 [1.82, 2.73]***	2.04 [1.62, 2.56]***
Female	0.62 [0.56, 0.69]***	1.05 [0.95, 1.16]	0.87 [0.79, 0.97]*
Prior achievement	1.04 [1.04, 1.05]***	1.02 [1.01, 1.02]***	1.00 [0.99, 1.00]
Socioeconomic status	1.07 [0.99, 1.16]	0.90 [0.83, 0.97]**	.88 [0.80, 0.96]**

Note. OR = odds ratio; CI = confidence interval. *Source.* U.S. Department of Education, Institute of Educational Sciences, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSL:09), Base Year.

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

interest, we found that most Asian adolescents, who are traditionally privileged in math, were more likely to maintain high expectancies for success and interest than switch from high to low beliefs (maintain high: 61% and 63%, switch from high to low: 39% and 37% [expectancies for success and interest, respectively]). For Latine adolescents, though many maintained high expectancies for success and interest, the proportions were more evenly split between maintaining high beliefs versus switching from high to low beliefs (maintain high: 56% and 53%, switch from high to low: 44% and 47% [expectancies for success and interest, respectively]). Our findings suggest that creating more equitable math environments may be important to address the racial/ethnic disparities in math. Also, the variability in developmental trends warrants future studies to test motivational belief development in diverse populations across a longer developmental span while accounting for potential variations in growth during various developmental ages.

Asian adolescents were more likely to display high stability than switch from high to low level in their expectancies for success and interest. Prior studies also noted that Asian students were more likely to display high expectancies for success and interest in math (C. Chen & Stevenson, 1995). Asian students often encounter the model minority stereotype and are perceived to be high performers in math (Trytten et al., 2012). In high school, these students may experience events that help them to positively evaluate their math abilities, such as being placed in a higher math course (Wang, 2012). Asian students often outperform and enroll in more advanced courses than students of other racial/ethnic

backgrounds, including White students, in math and science (e.g., National Science Foundation, 2019). Factors such as being in more advanced math courses, high math performance, or downward social comparisons with their peers may be some of the factors associated with maintaining high math expectancies for success and interest among Asian students. Nevertheless, it is also important to note that some Asian adolescents who initially had high beliefs displayed decreases from Grades 9–11 (39% for expectancies for success, 37% for interest). It is possible that the model minority stereotype may not always work in favor of all Asian students; the stereotype has been associated with negative academic attitudes as the pressure to conform to the stereotype can be challenging and stressful (McGee, 2018). Additionally, adolescents who display declines in math may endorse high expectancies for success or interest in other domains and perceive their math motivational beliefs to be lower compared to their motivational beliefs in other subjects (Eccles, 2009; Wang et al., 2013). The mechanisms that shape Asian adolescents' motivational beliefs, such as the potential buffering or hindering role of the model minority stereotype, need to be further examined.

Contrary to our hypothesis, many Black adolescents maintained high expectancies for success from Grades 9–11 rather than switch from high to low beliefs (maintain high: 62%, switch from high to low: 38%). Prior studies also found that Black students endorsed high expectancies for success despite being marginalized in math (e.g., Seo et al., 2019). Though Black students may display lower

Table 5
Logistic Regression Results With Grade 11 Motivational Beliefs as an Outcome for Asian and Black Groups

Variable	Maintaining high ES in Grade 11 (vs. switching to low ES) for students with high ES in Grade 9	Switching to high ES in Grade 11 (vs. maintaining low ES) for students with low ES in Grade 9	Maintaining high interest in Grade 11 (vs. switching to low interest) for students with high interest in Grade 9	Switching to high interest in Grade 11 (vs. maintaining low interest) for students with low interest in Grade 9	Maintaining high UV in Grade 11 (vs. switching to low UV) for students with high UV in Grade 9	Switching to high UV in Grade 11 (vs. maintaining low UV) for students with low UV in Grade 9
	OR [95% CI]	OR [95% CI]	OR [95% CI]	OR [95% CI]	OR [95% CI]	OR [95% CI]
Asian (n = 1,470)						
Perceived teacher unfairness	1.14 [0.71, 1.84]	1.01 [0.51, 1.99]	1.03 [0.65, 1.64]	1.05 [0.60, 1.84]	1.39 [0.72, 2.67]	1.89 [0.92, 3.86]
Parent-adolescent discussions	1.25 [0.49, 3.16]	4.07 [1.44, 11.46]**	1.32 [0.55, 3.19]	2.49 [0.88, 7.00]	2.67 [0.65, 10.90]	0.63 [0.19, 2.17]
Female	0.81 [0.49, 1.33]	0.75 [0.40, 1.40]	1.09 [0.67, 1.78]	0.58 [0.34, 0.96]*	1.29 [0.63, 2.65]	0.82 [0.32, 2.10]
Prior achievement	1.02 [1.00, 1.04]	1.03 [1.00, 1.07]*	1.03 [1.00, 1.06]*	1.03 [1.00, 1.07]	1.02 [0.99, 1.06]	1.00 [0.95, 1.05]
Socioeconomic status	0.90 [0.66, 1.24]	0.59 [0.38, 0.92]**	0.71 [0.50, 1.01]	0.80 [0.50, 1.27]	0.62 [0.34, 1.16]	0.83 [0.48, 1.47]
Black (n = 1,860)						
Perceived teacher unfairness	1.05 [0.78, 1.39]	0.94 [0.59, 1.51]	0.75 [0.56, 0.99]*	1.20 [0.86, 1.67]	1.02 [0.61, 1.70]	0.86 [0.44, 1.69]
Parent-adolescent discussions	1.05 [0.41, 2.70]	0.46 [0.17, 1.26]	0.72 [0.24, 2.20]	0.81 [0.32, 2.06]	1.07 [0.33, 3.51]	2.65 [0.45, 15.56]
Female	0.78 [0.46, 1.35]	1.15 [0.61, 2.18]	1.05 [0.73, 1.50]	2.02 [1.11, 3.67]*	0.81 [0.41, 1.59]	1.47 [0.62, 3.48]
Prior achievement	1.02 [1.00, 1.04]*	1.03 [1.01, 1.06]*	1.01 [0.99, 1.03]	1.02 [1.00, 1.05]	0.99 [0.97, 1.02]	1.00 [0.95, 1.06]
Socioeconomic status	0.76 [0.57, 1.02]	1.10 [0.70, 1.72]	1.01 [0.72, 1.41]	0.64 [0.41, 0.99]*	0.98 [0.65, 1.48]	0.83 [0.48, 1.41]

Note. ES = expectancies for success; UV = utility value; OR = odds ratio; CI = confidence interval. Source. U.S. Department of Education, Institute of Educational Sciences, National Center for Education Statistics, High School Longitudinal Study of 2009 (HLSLS:09), Base Year.
* $p < .05$. ** $p < .01$.

academic performance, they have been found to maintain positive self-regard and display high expectancies for success (e.g., Graham, 1994). Our findings suggest potential variability in the experiences of Black adolescents. That is, some Black adolescents in this study may experience more support in their learning, such as from their families or communities, which helps them maintain their high expectancies for success (e.g., Carlo, Murry, et al., 2022). Additionally, our findings suggest that math motivational beliefs other than expectancies for success, such as interest, may matter more for Black adolescents when making decisions about pursuing math or STEM. Exploring the mechanisms associated with Black adolescents' math trajectories will be important to address the racial/ethnic gaps in STEM.

Developmental Trends in Adolescents' Utility Value

In all racial/ethnic groups, adolescents were substantially more likely to find math to be useful in Grade 9 (71%–83%) and maintain their high utility value than switch from high to low utility value across Grades 9–11 (maintain high: 86%–92%, switch from high to low: 8%–14%). Even among the small percentage of adolescents who did not find math to be useful in Grade 9, most of them switched from low to high utility value by Grade 11 rather than maintaining their low utility value (switch from low to high: 67%–77%, maintain low: 23%–33%). Similar trends of high utility value during adolescence have been noted in other studies (e.g., Hsieh et al., 2021). Given that math is part of the core high school curriculum, adolescents may have found math to be useful for their future. Furthermore, their utility value may reflect the high utility value endorsed by their parents (Simpkins et al., 2015b). Parents' beliefs are directly associated with their children's beliefs (Eccles & Wigfield, 2020). When parents believe their child is skilled in math or find math to be useful for their child, it is likely to influence the child's own beliefs toward math for themselves (Simpkins et al., 2015b). Given that many parents are likely to perceive math as useful during this period, adolescents may also perceive high utility value. Additionally, math is often a gateway to many educational and occupational choices (Hulleman & Harackiewicz, 2021; Watt et al., 2017). Adolescents may have found math to be useful as they make close connections between their learning material and its personal relevance. That is, as adolescents consider going to college or finding a job, they may be more likely to consider math to be useful.

Socializers Likely Matter

Perceived teacher unfairness was negatively associated with all three motivational beliefs in Grade 9 for all racial/ethnic groups. Perceived teacher unfairness can lead to lower academic functioning in students by triggering their lack of belongingness (McKown, 2013). In addition to racial/ethnic identity, teachers may reinforce students' lack of belongingness in math due to other factors, such as their gender identity or their math abilities, and hinder their motivational belief development. Thus, we found that adolescents of all racial/ethnic backgrounds displayed lower concurrent expectancies for success, interest, and utility value when they perceived teacher unfairness, suggesting that equitable treatment by teachers likely matters in shaping students' math motivational beliefs.

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Table 6
Logistic Regression Results With Grade 11 Motivational Beliefs as an Outcome for Latine and White Groups

Variable	Maintaining high ES in Grade 11 (vs. switching to low ES) for students with high ES in Grade 9	Switching to high ES in Grade 11 (vs. maintaining low ES) for students with high ES in Grade 9	Maintaining high interest in Grade 11 (vs. switching to low interest) for students with high interest in Grade 9	Switching to high interest in Grade 11 (vs. maintaining low interest) for students with low interest in Grade 9	Maintaining high UV in Grade 11 (vs. switching to low UV) for students with high UV in Grade 9	Switching to high UV in Grade 11 (vs. maintaining low UV) for students with low UV in Grade 9
	OR [95% CI]	OR [95% CI]	OR [95% CI]	OR [95% CI]	OR [95% CI]	OR [95% CI]
Latine (n = 2,980)						
Perceived teacher unfairness	0.81 [0.59, 1.09]	1.24 [0.93, 1.65]	0.96 [0.70, 1.30]	0.81 [0.52, 1.25]	1.01 [0.73, 1.39]	0.86 [0.56, 1.33]
Parent-adolescent discussions	3.00 [1.11, 8.11]*	1.70 [0.80, 3.61]	1.73 [0.82, 3.63]	1.10 [0.55, 2.22]	0.92 [0.53, 1.58]	0.81 [0.29, 2.28]
Female	0.96 [0.67, 1.38]	0.64 [0.43, 0.97]*	1.06 [0.73, 1.55]	0.99 [0.69, 1.40]	0.75 [0.43, 1.31]	1.19 [0.66, 2.16]
Prior achievement	1.03 [1.01, 1.04]**	1.02 [1.00, 1.04]	1.04 [1.02, 1.05]***	1.02 [0.99, 1.05]	1.03 [1.00, 1.06]*	1.02 [0.98, 1.05]
Socioeconomic status	0.93 [0.71, 1.23]	1.04 [0.76, 1.42]	0.77 [0.59, 1.00]	0.89 [0.65, 1.22]	0.90 [0.65, 1.24]	0.77 [0.51, 1.17]
White (n = 10,810)						
Perceived teacher unfairness	0.93 [0.83, 1.03]	0.95 [0.83, 1.08]	0.87 [0.76, 1.00]	1.09 [0.96, 1.24]	0.75 [0.65, 0.87]***	0.99 [0.85, 1.17]
Parent-adolescent discussions	1.11 [0.84, 1.46]	0.94 [0.68, 1.29]	1.30 [1.01, 1.65]*	1.34 [1.00, 1.79]*	1.09 [0.76, 1.55]	1.14 [0.81, 1.60]
Female	0.61 [0.53, 0.71]**	0.82 [0.69, 0.97]*	0.86 [0.76, 0.99]*	1.02 [0.86, 1.20]*	0.96 [0.81, 1.14]	0.82 [0.66, 1.02]
Prior achievement	1.04 [1.03, 1.05]***	1.03 [1.02, 1.04]***	1.03 [1.02, 1.04]***	1.02 [1.01, 1.03]***	1.02 [1.02, 1.03]***	1.01 [1.00, 1.02]**
Socioeconomic status	0.98 [0.88, 1.09]	1.01 [0.89, 1.14]	0.93 [0.84, 1.03]	1.06 [0.93, 1.22]	0.91 [0.79, 1.06]	0.85 [0.73, 0.98]*

Note. ES = expectancies for success; UV = utility value; OR = odds ratio; CI = confidence interval. Source: U.S. Department of Education, Institute of Educational Sciences, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSL:09), Base Year.
* $p < .05$. ** $p < .01$. *** $p < .001$.

Many significant associations between socializers' behaviors and adolescents' motivational beliefs emerged concurrently but not longitudinally. The effects may not have lasted 2 years later because adolescents' teachers and socializers' behaviors can change over time. If, for example, adolescents have positive experiences with their math teacher in Grades 10 or 11, the effects of encountering unfair treatment from their Grade 9 teacher may lessen. Future studies could test multiple types of socializers' behaviors, include multiple time points, or examine interactions to understand further the relations between socializers' behaviors and adolescents' motivational belief development.

Nevertheless, there were a few significant longitudinal associations that emerged between socializers' behaviors and adolescents' motivational beliefs 2 years later. Particularly, perceived teacher unfairness may be related to a negative change in interest among Black adolescents. Though marginally related using multiple-imputed data, we found that Black adolescents who perceived high teacher unfairness in Grade 9 were less likely to maintain high interest but switch from high to low interest across Grades 9–11. Prior studies noted that the perceptions of negative stereotypes in academic contexts, especially in math, are likely to function as an identity threat for Black students (Wang & Degol, 2013; Wigfield & Gladstone, 2019). Given the strong correlations between interest and identity (e.g., Trautwein et al., 2012), the negative experiences that hinder Black adolescents' identity in math may have also led to declines in their interest. Nevertheless, having a supportive teacher who displays high expectations for these adolescents and practices equity-minded teaching may also foster positive motivational belief development in these adolescents (Joseph et al., 2019). Teacher support that challenges the traditional negative stereotypes may be especially critical for positive motivational belief development among Black adolescents. Overall, we found that addressing the challenges that adolescents face in their classrooms and with their teachers may matter for many adolescents of all racial/ethnic groups, and especially among Black adolescents.

Additionally, parent–adolescent discussions were positively related to some changes in motivational beliefs among Asian, Latine, and White adolescents. Notably, we found that parents may promote positive changes in expectancies for success for Asian and Latine adolescents, where parent–adolescent discussions were related to maintaining high expectancies for success among Latine adolescents and switching from low to high expectancies for success among Asian adolescents. Given that family and family connectedness are some of the core values in these cultures, parental support might have been especially helpful in fostering their motivational beliefs (Carlo, Cheah, et al., 2022). For example, familism has been found to be a cultural value that facilitates positive development among Latine adolescents (Carlo, Murry, et al., 2022). Despite many challenges that are experienced in these families, such as cultural differences and structural barriers, parents who devote their time to discuss STEM and adolescents' future plans may help these youth to develop positive motivational beliefs in math (Hsieh & Simpkins, 2022; Lee & Simpkins, 2021; Starr, Ramos Carranza, & Simpkins, 2022).

Interestingly, parent–adolescent discussions were not a significant predictor of Black adolescents' motivational belief development. For Black adolescents, parental support other than discussions or discussions that involve other conversation topics may be more strongly associated with promoting their motivational beliefs. Effective parenting practices are likely to vary by racial/ethnic group

(McKown, 2013). For example, McKown (2013) noted that parents' strict and less sensitive parenting practices can also be academically helpful among Black children. Parental beliefs also influence students' motivational beliefs (Eccles & Wigfield, 2020). Though not tested in this study, parents' high expectations or beliefs that challenge the existing stereotypes may help Black adolescents to display high motivational beliefs (e.g., Fredricks & Eccles, 2002). For example, Black parents are more likely to hold gender egalitarian views in math compared to Asian and White parents (Starr, Gao, et al., 2022). In fact, only among Black adolescents, we consistently found no gender differences across all motivational beliefs in Grade 9 and one gender difference across Grades 9–11, where female adolescents were more likely than male adolescents to switch from low to high interest rather than maintain low interest, which aligns with other research (e.g., Rubach et al., 2022). To better understand the diverse experiences of adolescents from different races/ethnicities, various types of parental support will need to be explored.

Limitations and Future Directions

Despite the significant findings of this study, it is not without limitations. First, correlational data was used for this study. Our findings, particularly in relation to the roles of parents and teachers, should be interpreted without any causal implications. Second, adolescents' perceptions of teacher unfairness may have been inferred from teachers' behaviors toward other students and not themselves. The items asked how teachers treat students generally and not how teachers treat the individual. Even though our correlations displayed significant negative associations between perceived teacher unfairness and motivational beliefs (Table 2 and 3), they may underestimate the impact of teacher unfairness as directed toward particular individuals. Third, we measured parent–adolescent discussions about academic plans, math course-taking, and STEM. Though parent–adolescent discussions have been found to strongly predict adolescents' motivational belief development, other types of parental support or conversations around other topics may also be critical in fostering adolescents' motivational beliefs. Particularly, our findings suggest that it may be worth exploring various types of parental support in diverse racial/ethnic groups as there may be differences in parental support that are more beneficial than others by race/ethnicity. Fourth, we dichotomized our motivational belief variables for our analyses which reduced the variances of these variables. Nevertheless, we conducted supplemental analyses with the original continuous variables and found largely consistent results. Last, we examined race/ethnicity as an indicator of social background, but other social backgrounds (e.g., gender, immigration status) are also worth exploring. Future studies could extend this study and include more detailed measures of teacher/parental involvement and indicators of adolescents' social background.

Conclusion

In this study, we found that there were multiple theoretically distinct developmental trends in adolescents' motivational beliefs in each racial/ethnic group. In general, adolescents often maintained their Grade 9 expectancies for success rather than demonstrate change (from low to high or high to low). Though adolescents' interest was often stable or declined, adolescents were more likely to maintain high utility value or demonstrate increases. Socializers' behaviors were

significantly associated with adolescents' motivational beliefs concurrently, but much less so longitudinally—a trend that emerged across all racial/ethnic groups. Nevertheless, parent–adolescent discussions significantly predicted positive development in expectancies for success among Asian and Latine adolescents. Perceived teacher unfairness increased the likelihood of Black adolescents switching from high to low interest. The findings from this study highlight the various trends in adolescents' math motivational belief development and the potential role of social contexts in shaping motivational beliefs. Consequently, this study demonstrates the need to continue our effort to implement effective interventions in high schools targeted toward students, teachers, and parents. Until now, there have been many intervention efforts to boost students' utility value (Hulleman & Harackiewicz, 2021; Rosenzweig et al., 2022). Our findings suggest, at least in high school, interventions to boost other motivational beliefs described in situated expectancy–value theory, especially interest, may be worthwhile in addressing the disparities in math. Another critical implication of our findings is that equity-minded practices from teachers and adequate parental support may matter in helping adolescents, especially those from marginalized groups, to challenge the existing societal stereotypes. Moving forward, researchers should continue to investigate diversity in adolescent development and various factors that can influence adolescent development to suggest ways to foster positive motivational beliefs in all youth.

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